TSL3000E series Robot Controller

TSL3000E SCARA system
TSL3100E 6-Axis system

INTERFACE MANUAL

Notice

- Make sure that this instruction manual is delivered to the final user of Toshiba Machine's industrial robot.
- Before operating the industrial robot, read through and completely understand this manual.
- After reading through this manual, keep it nearby for future reference.

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The information contained in this manual is subject to change without prior notice to effect improvements.

Preface

This manual describes the type, function and handling method of external cables connecting the TSL3000E/TSL3100E robot controller with external equipment.

This manual is intended for the system designers and manufacturing engineers. The TSL3000E/TSL3100E robot controller can work in concert with the external equipment through digital input and output signals that can be programmed by the SCOL language. Also, system input signals that can allows external operation of the controller, system output signals informing an operator of the controller status (PLC processing function) and serial input and output signals that can be connected with the host computer, etc., are provided so that the user can easily construct an FA system.

* Instruction manuals which are referred to from this manual

Installation & Transport Manual
Maintenance Manual
Safety Manual
Operation Manual
User Parameter Manual
Simple PLC Function Manual
Communication Manual

! **CAUTION**	This manual does not contain any detailed descriptions on power and robot connection. For the connection of the power and robot, see the Installation & Transport Manual.

Cautions on Safety

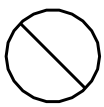
This manual contains the important information on the robot and controller to prevent injury to the operators and persons nearby, to prevent damages to assets and to assure correct use.
Make sure that you well understand the following details (indications and symbols) before reading this manual. Always observe the information that is noted.

[Explanation of indications]

Indication	Meaning of indication
 **DANGER**	This means that "incorrect handling will lead to fatalities or serious injuries."
 **CAUTION**	This means that "incorrect handling may lead to personal injuries *1) or physical damage *2)."

*1) Injuries refer to injuries, burns and electric shocks, etc., which do not require hospitalization or long-term medical treatment.
*2) Physical damage refers to damages due to destruction of assets or resources.

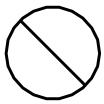
[Explanation of symbols]

Symbol	Meaning of symbol
	This means that the action is prohibited (must not be done). Details of the actions actually prohibited are indicated with pictures or words in or near the symbol.
	This means that the action is mandatory (must be done). Details of the actions that must be done are indicated with pictures or words in or near the symbol.
	This means danger. Details of the actual danger are indicated with pictures or words in or near the symbol.
	This means caution. Details of the actual caution are indicated with pictures or words in or near the symbol.

! **CAUTION**	To perform the work ranging from robot installation to operation with safety, read through and through the Safety Manual provided separately before actually starting the work.

Maintenance and Inspection

To use the robot safety, strictly observe the following matters.

! DANGER	
 Prohibited	• NEVER burn, disassemble or charge the battery. Otherwise, it may explode.
 Mandatory	• Before performing the maintenance and inspection, be sure to turn off the main power switch of the controller. • When disposing of batteries, be sure to follow the user's regulations.

! CAUTION	
 Disassembly Prohibited	• The user should NEVER replace or change parts other than those stipulated in the instruction manual. Otherwise, the performance will deteriorate, resulting in troubles.
 Mandatory	• To replace parts, use the spare parts designated by Toshiba Machine. • Carry out the maintenance and inspection on a regular basis. Otherwise, the equipment may go wrong or accidents will be caused.

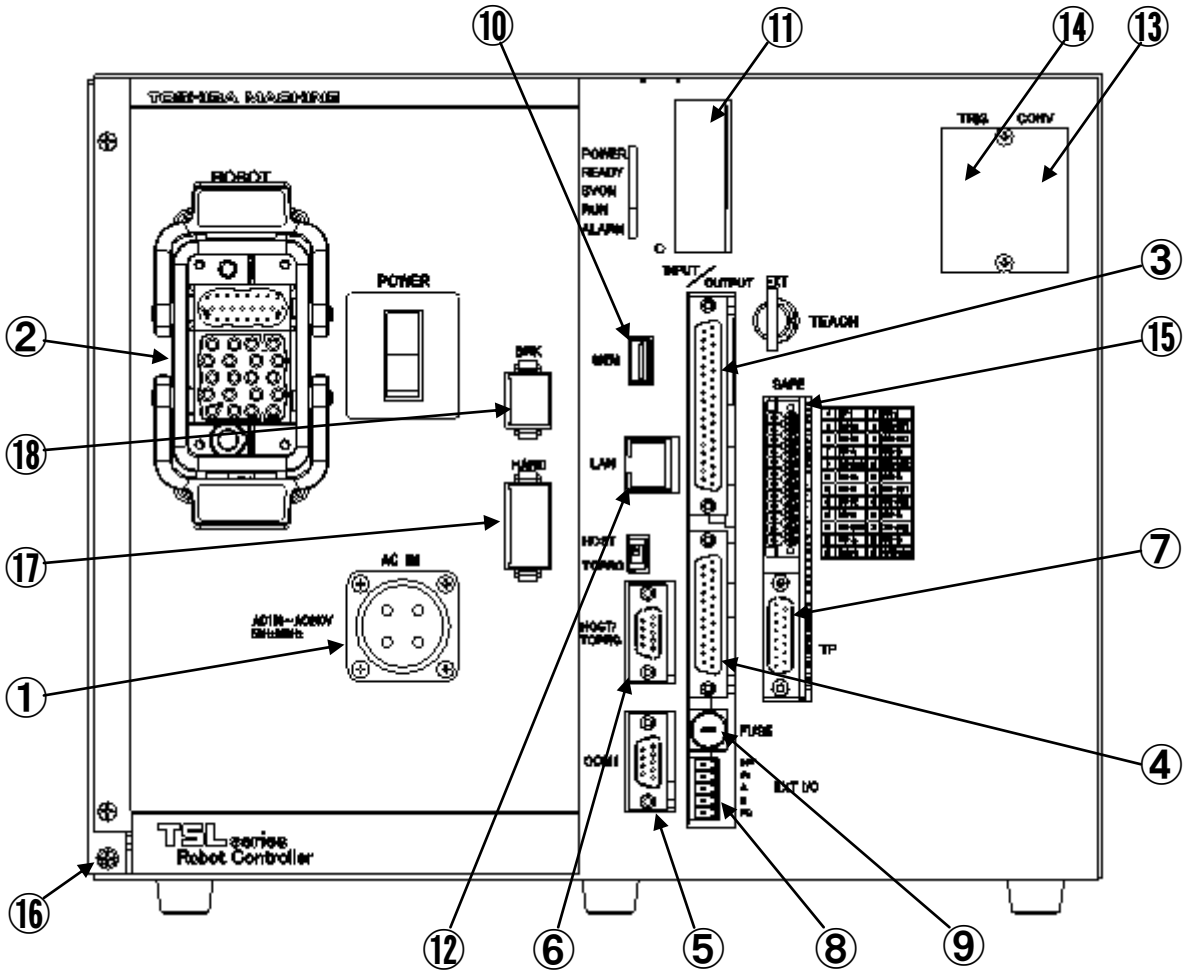
! CAUTION	
	To perform the maintenance and inspection of the robot with safety, read through and through the Maintenance Manual provided separately before actually starting the work.

Table of Contents

Section 1 Type of External Cable

1.1 Layout and Name of Connectors (4-Axis Type/6-Axis Type combined)

The TSL3000E/TSL3100E robot controller is connected with the robot and external equipment, using connectors and terminal blocks provided on the front and rear panels of the controller.



Front panel

Fig. 1.1 Layout and name of connectors

1.2 Power Cable "AC IN"

Fig. 1.1–① (with connector)

The power cable is an interface feeding the main power (single phase, 190/240 V AC, 50/60 Hz) to the TSL3000E/TSL3100E robot controller. Connector "AC IN" is used.

For details, see the Installation & Transport Manual provided separately.

1.3 Motor, Encoder "ROBOT"

Fig. 1.1–②

The motor drive cable connects the TSL3000E/TSL3100E robot controller and robot. It feeds the 3-phase AC power to each axis feed motor of the robot. The encoder cable controls the encoder signal for rotation angle detection of each robot axis. Connector "ROBOT" is used.

For details, see the Installation & Transport Manual provided separately.

1.4 Hand I/O Cable "HAND"

Fig. 1.1–⑰

The hand I/O cable connects the TSL3000E/TSL3100E robot controller and robot. It controls the hand at the end of the robot. Connector "HAND" is used.

For details, see the Instruction Manual: Installation & Transport provided separately.

1.5 Brake Cable "BRK"

Fig. 1.1–⑱

The brake cable connects the TSL3000E/TSL3100E robot controller and robot. It controls the parking brake signal for securing the motor shaft to each axis feed motor of the robot. Connector "BRK" is used.

For details, see the Instruction Manual: Installation & Transport provided separately.

1.6 External I/O Signal Cable

1.6.1 Safety Input Signal Cable "SAFE"

Fig. 1.1–⑮ (with connector)

The safety input signal cable is an interface connecting emergency stop input and safety door signal input to the TSL3000E/TSL3100E robot controller from the external equipment. This is provided with dual-redundant c-contact outputs that indicate emergency stop status and safety door status of the controller, and facilitates connection with the high-order sequencer. Connector "SAFE" is used.

1.6.2 External Input Signal Cable "INPUT"

Fig. 1.1–③ (with dummy connector)

The external input signal cable is an interface recognizing each signal which is input to the TSL3000E/TSL3100E robot controller from the external equipment.
The external input signal comes in eight (8) digital input signals that can be programmed at the user's discretion, using the SCOL language or PLC function and thirteen (13) system input signals that allow operation of the controller from the external equipment. This signal, together with the external output signal in Para. 1.4.2, allows the robot controller to work in concert with the external equipment.
Also, three (3) system input signals of external servo ON, external servo OFF and external emergency stop are included in this cable. Connector "INPUT" is used.

1.6.3 External Output Signal Cable "OUTPUT"

Fig. 1.1–④ (with connector)

The external output signal cable is an interface which outputs each signal from the TSL3000E/TSL3100E robot controller to the external equipment.
The external output signal comes in eight (8) digital output signals that can be programmed at the user's discretion, using the SCOL language or PLC function and system output signals that output the controller status to the external equipment.
This signal, together with the external input signal in Para. 1.4.1, allows the robot controller to work in concert with the external equipment.
Connector "OUTPUT" is used.

1.7 Serial I/O Signal Cable

1.7.1 Serial I/O Signal "COM1"

Fig. 1.1–⑤

Serial I/O signal cable COM1 is exclusively used for the RS232C and allows data communication with an image processing equipment or other FA equipment that can connect an RS232C interface. Connector "COM1" is used.

1.7.2 Serial I/O Signal "HOST"/TCPRG

Fig. 1.1–⑥

Serial I/O signal cable HOST/TCPRG is exclusively used for the RS232C and HOST allows transfer and saving of various parameters and updating of the system when connected with the host computer.

The TSL3000E/TSL3100E robot controller uses exclusive sequence control tool "TCPRGOS" (option) to transfer, save and monitor sequence programs.

TCPRG is the connector to connect with this sequence control tool.

For the use of TCPRGOS, see the Simple PLC Function Manual (option) provided separately.

The connector "HOST/TCPRG" is used. The setting can be switched between "HOST" and "TCPRG" using the switch above the connector.

1.8 Teach Pendant Cable "TP"

Fig. 1.1–⑦ (with dummy plug)

This is an interface connecting the TSL3000E/TSL3100E robot controller and teach pendant (TP). The teach pendant is an option. By connecting the TP cable, creation of motion programs, manual robot guidance, etc., are possible through the teach pendant. Connector "TP" is used. The TP cable is secured to the teach pendant and cannot be disconnected from the teach pendant. The standard cable length is 5 m.

1.9 FUSE Cable "FUSE"

Fig. 1.1–⑨

This is a fuse for detecting overcurrent (3A) of the digital signal input/output to the TSL3000E/TSL3100E robot controller. It is used for protecting patterns. "FUSE" is located in the bottom section of the front panel.

1.10 I/O P24V Supply and Remote I/O Cable

Fig. 1.1–⑧

This is a connector for external power supply connection for setting INPUT, OUTPUT, and the INPUT and OUTPUT for HAND to ON or OFF. P24V is supplied externally. This connector is shared with a connector for remote I/O connection. This is an RS485 communication terminal connecting the TSL3000E/TSL3100E robot controller with the optional remote I/O module function (TR48DIOCN/TR48DIOC module, etc.). Terminal block "EXT I/O" is used. For details of the TR48DIOCN/TR48DIOC, see the Extension I/O Function Manual (option).

1.11 MEM Cable "MEM"

Fig. 1.1–⑩

A USB memory device can be used to transfer and save the parameters and back up the programs and other data. The connector "MEM" is used.

1.12 LAN Cable "LAN"

Fig. 1.1–⑬

This supports connection by 10BASE-T, in the TSL3000E/TSL3100E robot controller. If a hub is used, a straight cable is used. If the computer and controller are connected directly one-to-one, a cross cable is used. Also, TCP/IP protocol can be used to perform communication with computers or visual equipment on the Ethernet within the same local area for enabling the creation and editing of programs using the computer programmer TSPC and debugging start assistance and maintenance.

1.13 PE Cable "PE"

Fig. 1.1–⑯ (with M4 screw)

The PE cable connects the PE ground terminal of the TSL3000E/TSL3100E robot controller in order to prevent electric shock. Connect the PE using a 2.0 mm^2 cable whose length is 1 m or shorter with a green grounding wire or a green and yellow grounding wire. Do not attach any switch or overcurrent protection device to the PE cable.

1.14 Fieldbus Cable "Fieldbus"

Fig. 1.1–⑪ (option)

This supports connection with fieldbus devices, which is available as an option function in the TSL3000E/TSL3100E robot controller. PROFIBUS, DeviceNet, or CC-Link can be selected as the type of fieldbus for the slave module. "FieldBUS" is located in the top section of the front panel.

1.15 CONV Cable "CONV"

Fig. 1.1–⑬ (option with connector)

This is used to use the conveyor synchronization function. Use the encoder provided with A- and B-phase signals having 90° phase and the output circuit having RS-422 differential output (line driver). The signal from the incremental encoder and the input signal from the conveyor synchronization start trigger switch are required.

1.16 TRIG Cable "TRIG"

Fig. 1.1–⑭ (option with connector)

This cable comes standard with eight (8) trigger input functions. This is used for data latch function, conveyor synchronization function, etc. The D-sub15-pin connector located on the top of the front panel is "TRIG." Connector "TRIG" is used.

1.17 Extension I/O Signal Cable

1.17.1 Extension Input Signal Cable "INPUT (TR)"

Fig. 7.3–⑭ (option)

This is an interface which inputs an external signal from the external equipment to remote I/O module TR48DIOCN/TR48DIOC. Like the external input signal cable, the extension input signal cable is provided with twenty-eight (28) digital input signals that can be programmed at the user's discretion, using the SCOL language or PLC function. The extension input signal, together with the external output signal or extension output signal, allows the robot controller to work in concert with the external equipment. Connector "INPUT (TR)" is used.

Note: To discriminate from the INPUT cable connector of the TSL3000E/TSL3100E robot controller, the extension input signal cable connector is referred to as "INPUT (TR)" in this manual.

1.17.2 Extension Output Signal Cable "OUTPUT (TR)"

Fig. 7.3–⑮ (option)

This is an interface which outputs an external signal from remote I/O module TR480DIOCN/TR48DIOC to the external equipment. Like the external output signal cable, the extension output signal cable is provided with twenty (20) digital output signals that can be programmed at the user's discretion, using the SCOL language or PLC function. The extension output signal, together with the external input signal or extension input signal, allows the robot controller to work in concert with the external equipment. Connector "OUTPUT (TR)" is used.

Note: To discriminate from the OUTPUT cable connector of the TSL3000E/TSL3100E robot controller, the extension output signal cable connector is referred to as "OUTPUT (TR)" in this manual.

Section 2 Power Cable

2.1 Connecting the Power Cable

To connect the TSL3000E/TSL3100E power cable, use the attached connector.

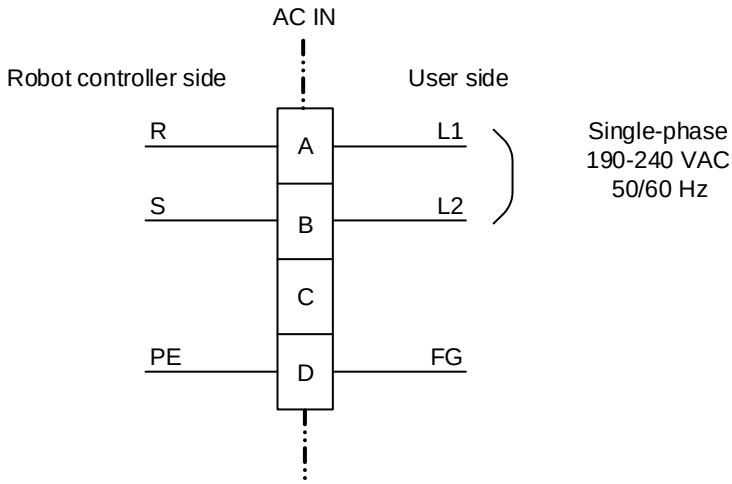


Fig. 2.1 Connection of power cable

Plug connector model: JL04V-6A18-10SE-EB
Manufacturer: JAE (Japan Aviation Electronics Industry, Limited)
JL04-18CK(13)
Manufacturer: JAE (Japan Aviation Electronics Industry, Limited)
Cable: 2.0 mm^2 (AWG#14)

The cable is not included in the accessories. The attached plug connector connected to the ACIN of the controller is soldering type. The customer must use the attached connector to fabricate the cable.

Table 2.1 Power Supply Specifications

Power supply	Single-phase 190-240 V AC 50/60 Hz ± 1 Hz
Power capacity	Varies depending on the robot to be connected.
Instantaneous power failure	40 msec or less
Ground	Class D dedicated grounding

Be sure to ground the PE ground terminal to prevent electric shock.

A ground-fault circuit interrupter must be installed on TSL3000E/TSL3100E by the customer.
Specifications: Single phase 20 A, sensitivity current 30 mA
Recommended ground-fault circuit interrupter:
BKW2203CCK by Panasonic Electric Works, Co., Ltd.

Note the following when installing a ground-fault circuit interrupter.

- A ground-fault circuit interrupter must be installed for each power supply to the machine.
- "O" (open) or "|" (closed) must be indicated as the operation status.
- The ground-fault circuit interrupters must be equipped with an external operating mechanism (e.g., a handle) and installed 0.6 m to 1.9 m above the ground so that they can be easily accessed.
- All the power circuit phases must be shut down. However, DO NOT disconnect the ground wire or PE cable.

For details on the power cable connection, see the Installation & Transport Manual provided separately.

! CAUTION

In order to prevent direct or indirect contact with the robot controller, provide a sufficient distance between the robot controller and the operator, for example, by placing the robot controller in an enclosure.
If the robot controller is contained in an enclosure, the enclosure must be a fixed-cover structure or it must be locked not to be opened/closed freely.
Take protective measures when making the cable inlet in the enclosure so that the cables will not be damaged.

Section 3 Robot Control Cable

3.1 TSL3000E Motor Drive Cable (4-Axis Type)

To connect the motors, use the attached cables.

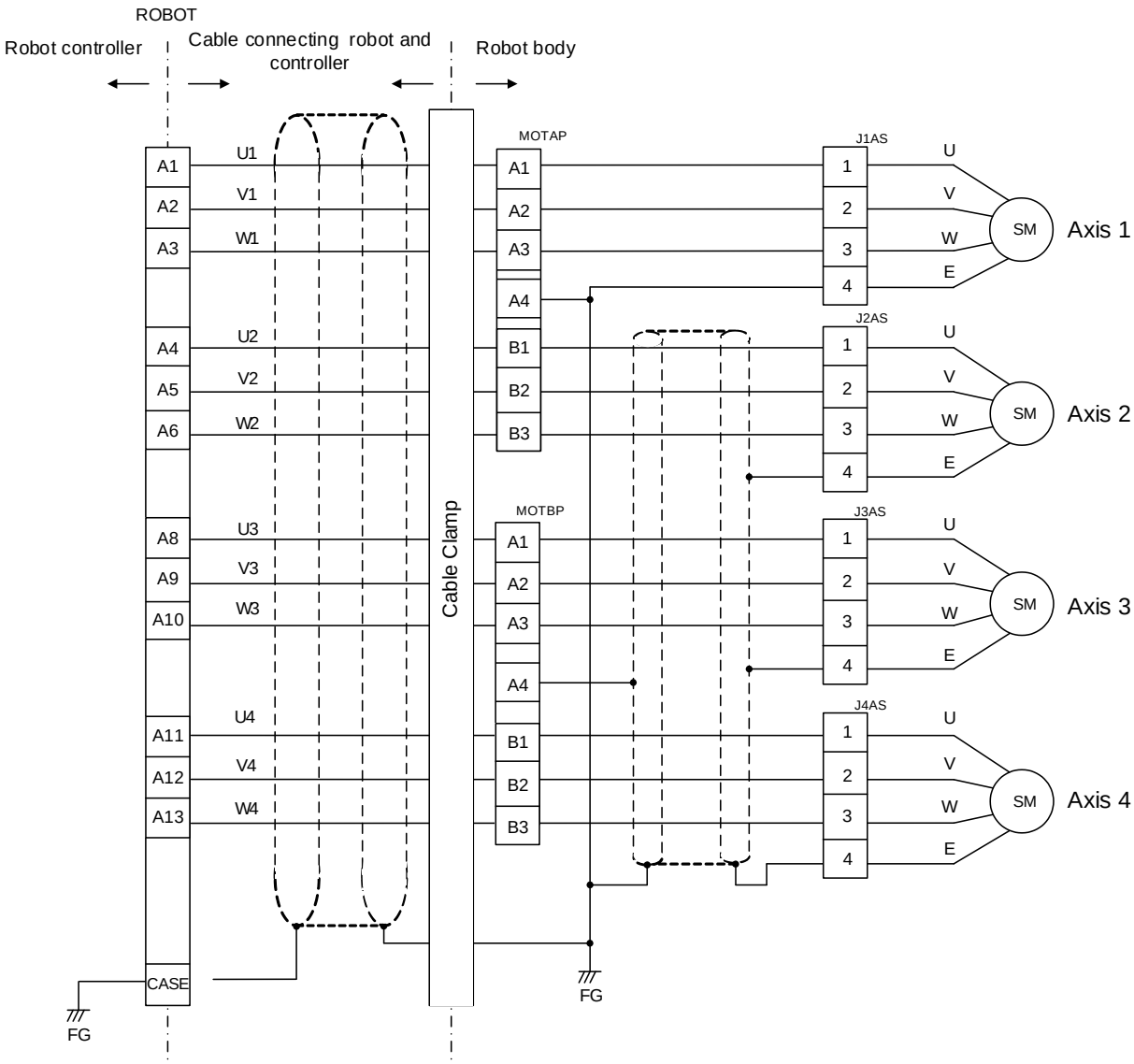


Fig. 3.1 Connection of motor drive cables

3.2 TSL3100E Motor Cable (6-Axis Type)

To connect the motors, use the attached cables.

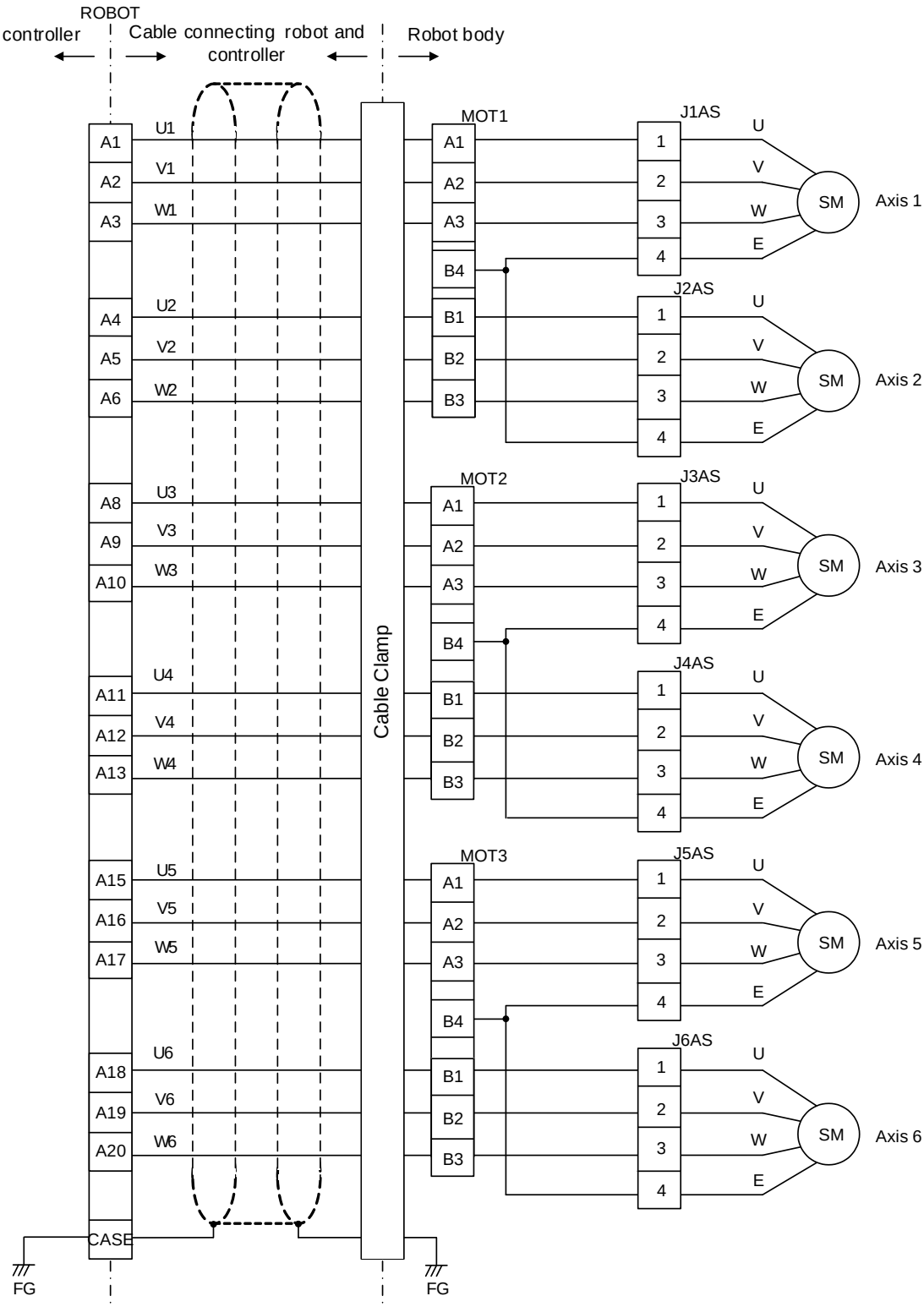


Fig. 3.2 Connection of motor drive cables

3.3 TSL3000E Brake Cable (4-Axis Type)

To connect the brakes, use the attached cables.

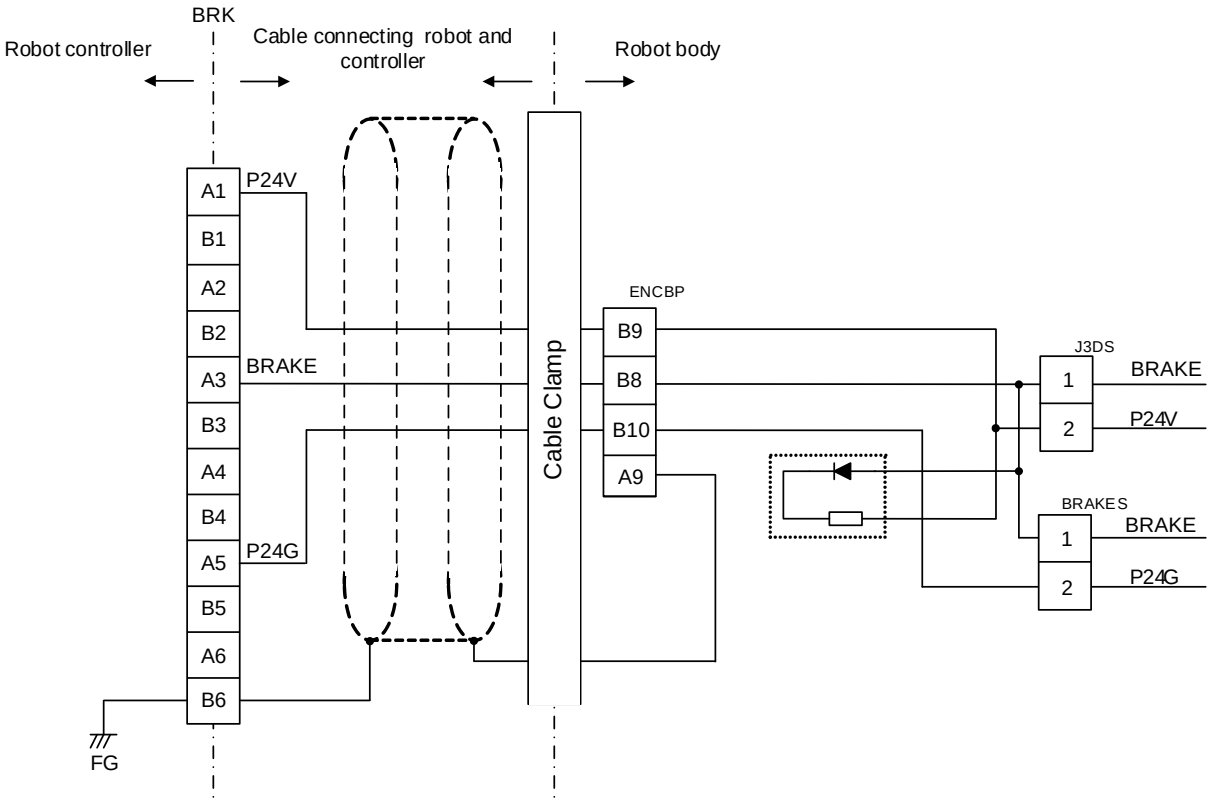


Fig. 3.3 Connection of brake cables

3.4 TSL3100E Brake Cable (6-Axis Type)

To connect the brakes, use the attached cables.

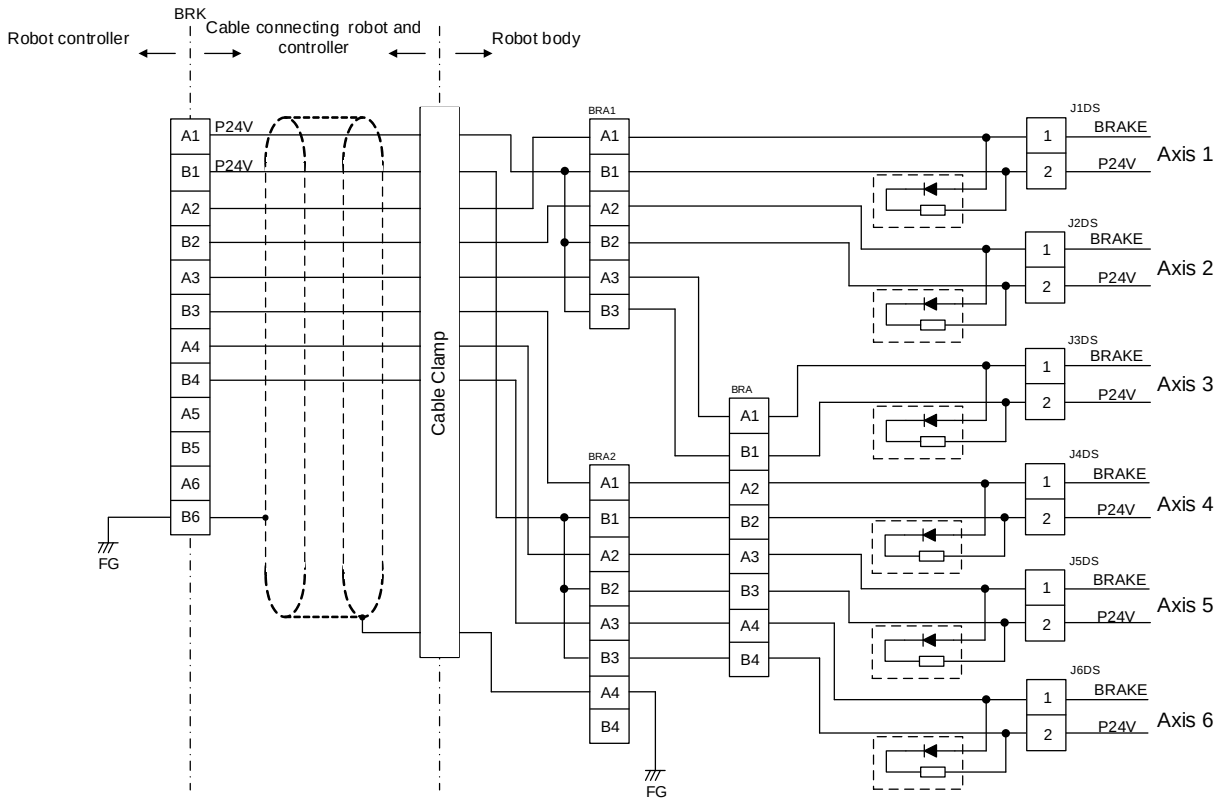


Fig. 3.4 Connection of brake cables

For the motor drive cable connection, see the Installation & Transport Manual.

3.5 TSL3000E Encoder Cable

To connect the encoders, use the attached cables.

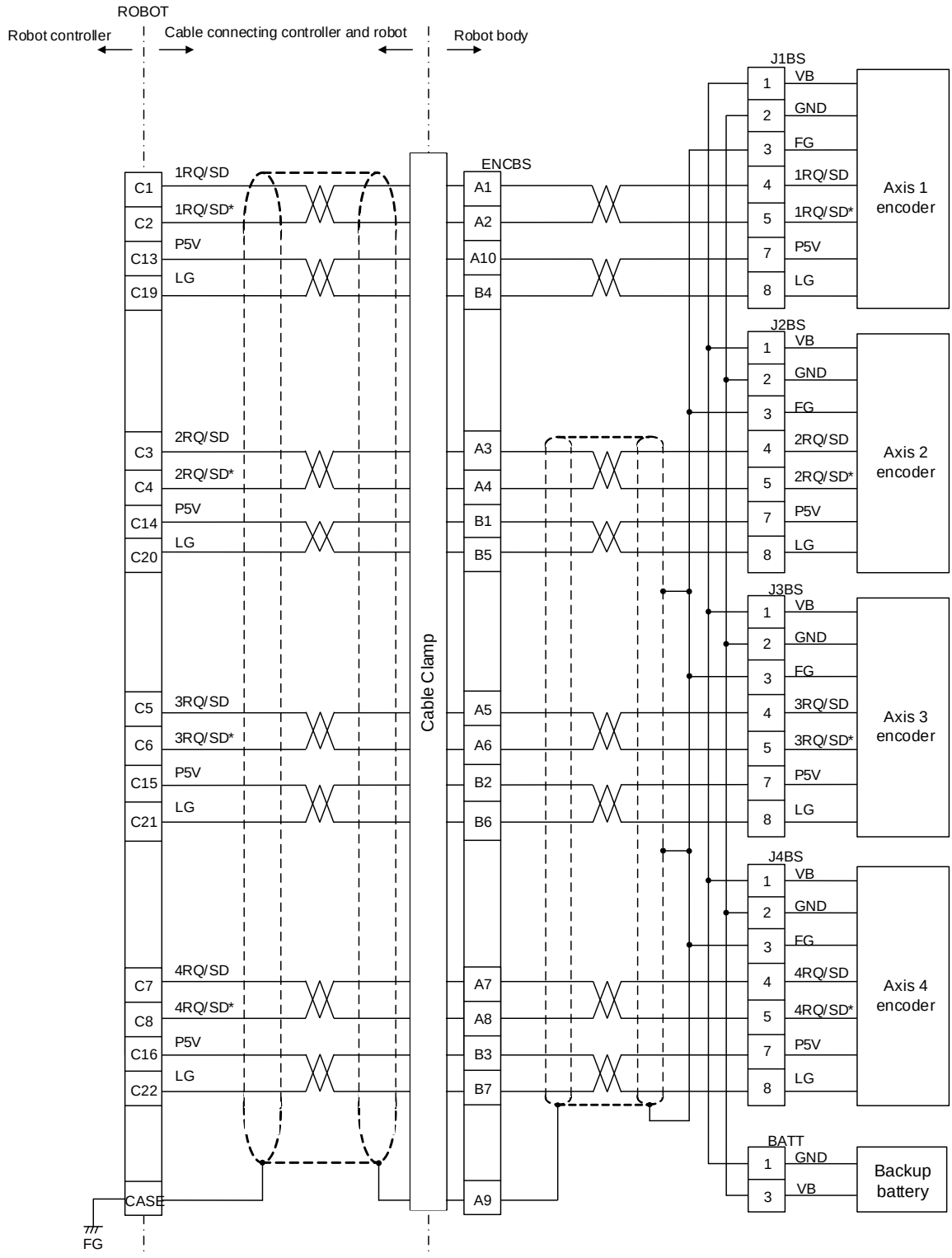


Fig. 3.5 Connection of encoder cables

3.6 TSL3100E Encoder Cable (6-Axis Type)

To connect the encoders, use the attached cables.

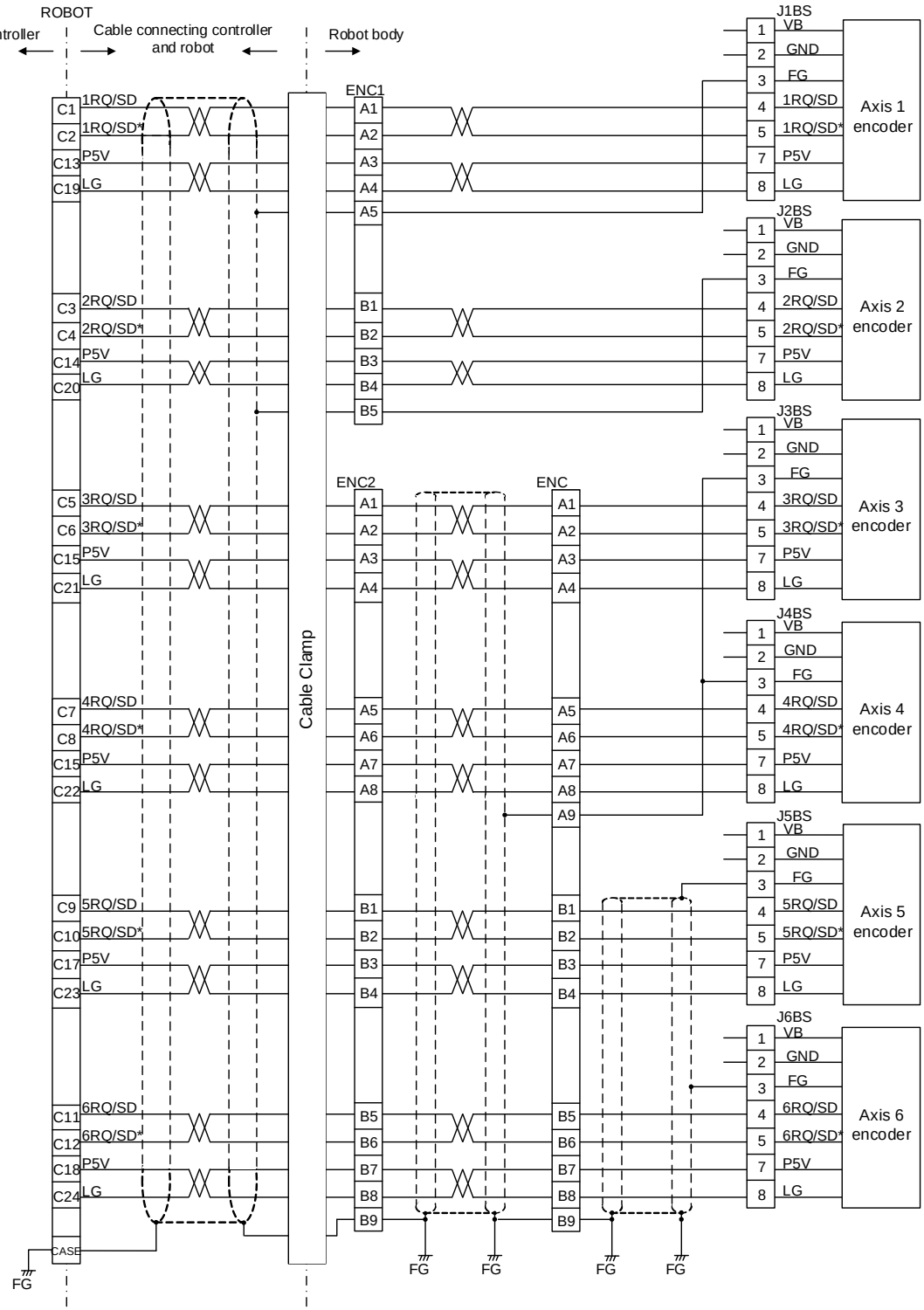


Fig. 3.6 Connection of encoder cables

For the encoder cable connection, see the Installation & Transport Manual.

3.7 Connecting Hand I/O Signal Cable (THL Series)

Use the supplied cable to connect the robot control signal cable. The input common signal is shared with the SYSINCOM signal (17 and 30 pins) in the INPUT connector on the front panel of the controller, and the output common signal is shared with the SYSOUTCOM signal (10 and 23 pins) in the OUTPUT connector. To use a user's special system, use the attached connector XM3A-2521 (plug type connector), XM2S–2511 (connector cover)] for connecting the CN0 cable (motor drive power connections) on the robot side.

Connection for Type N

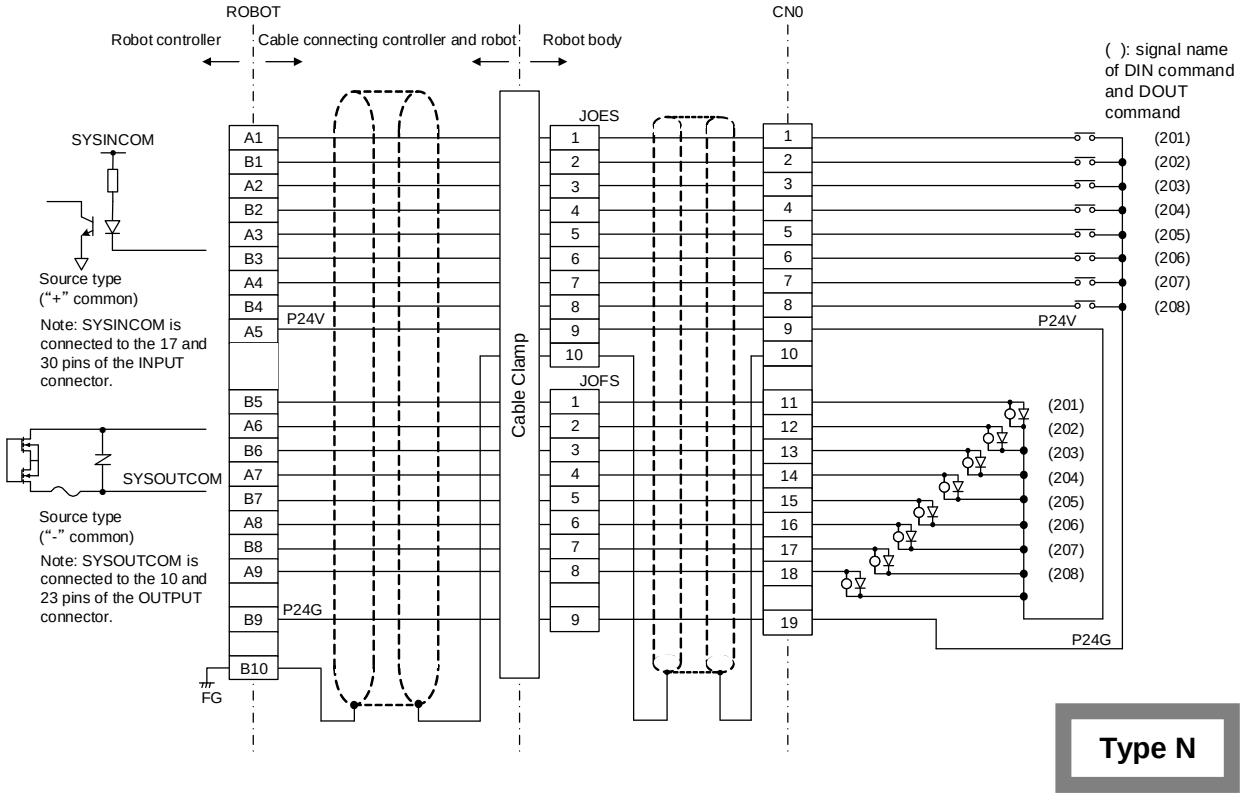


Fig. 3.7 Connection of hand I/O signal cable (Type N)

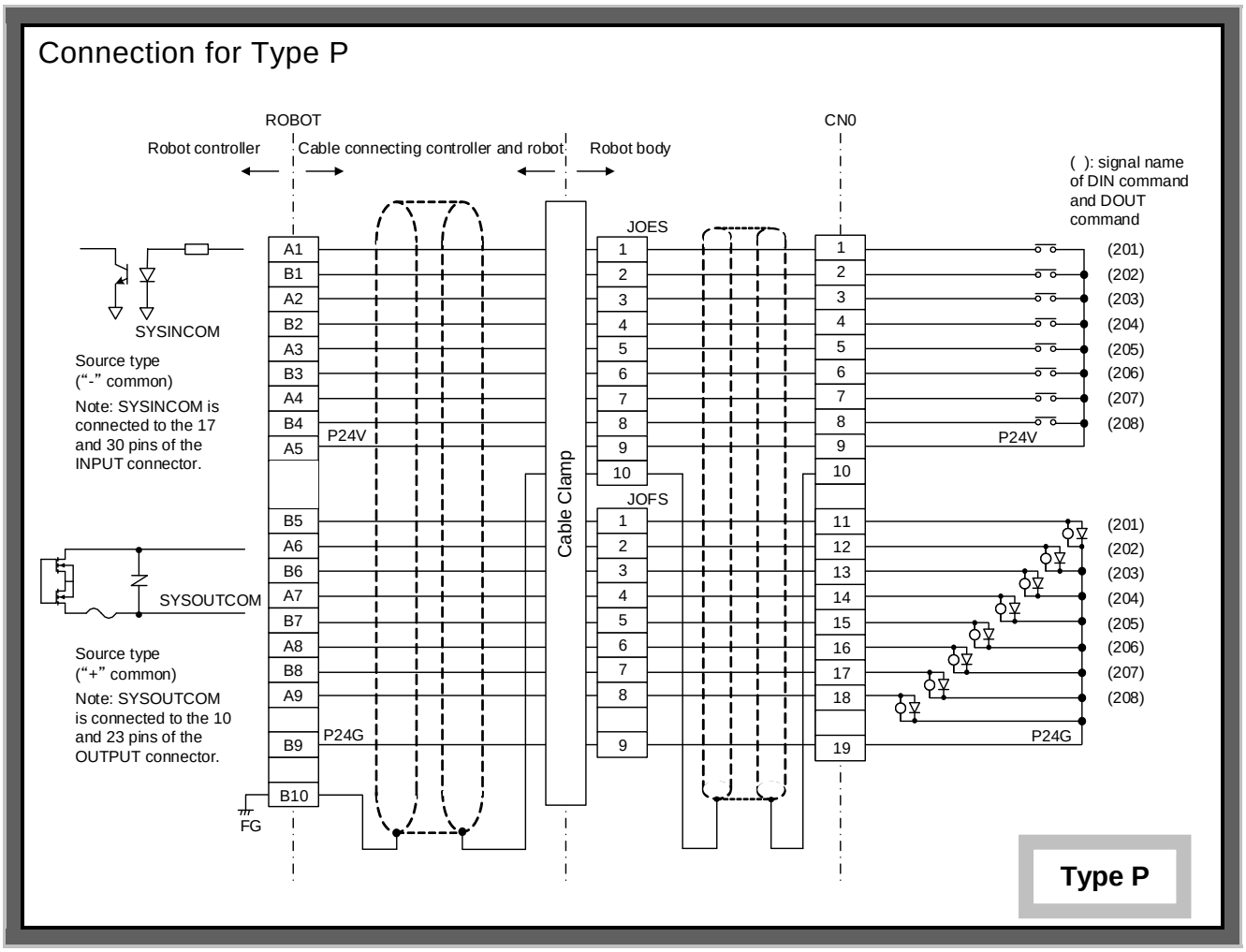


Fig. 3.8 Connection of hand I/O signal cable (Type P)

3.8 Connecting Hand I/O Signal Cable (TVL Series)

To use a user's special system, use the attached HAND motor drive power connections on the robot side. The cables are not attached. Appropriate cables should be used. When using this function, use of exclusive cables (option) is recommended. For details, contact our after-sale service agent in your territory.

Connection for Type N

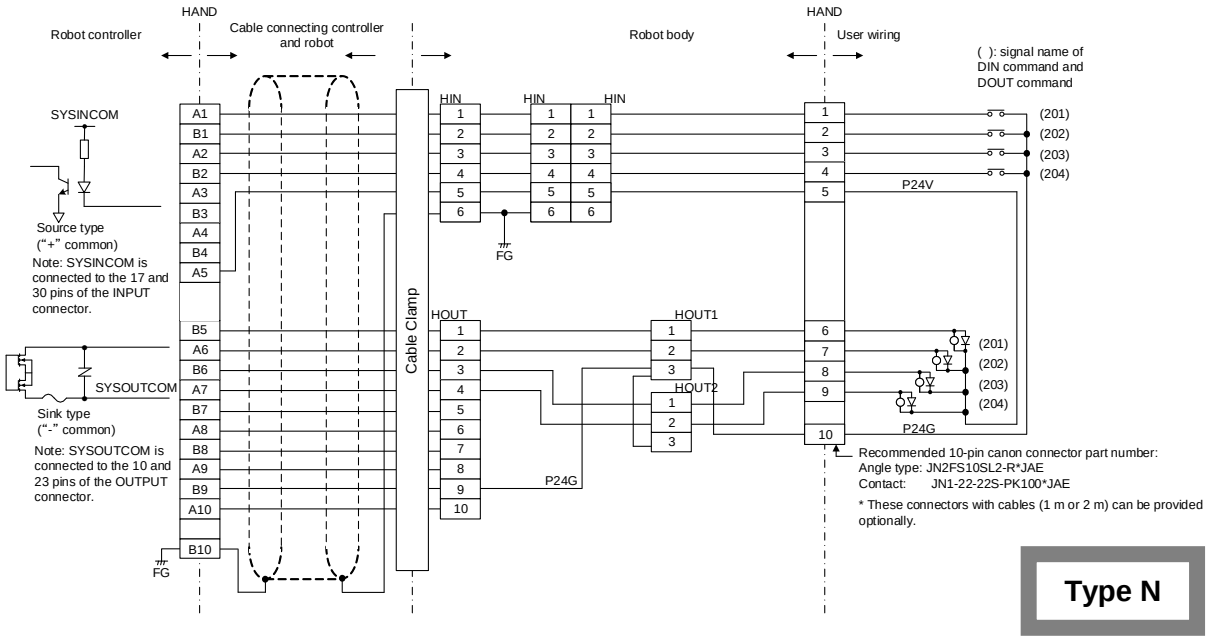


Fig. 3.9 Connection of hand I/O signal cable (Type N)

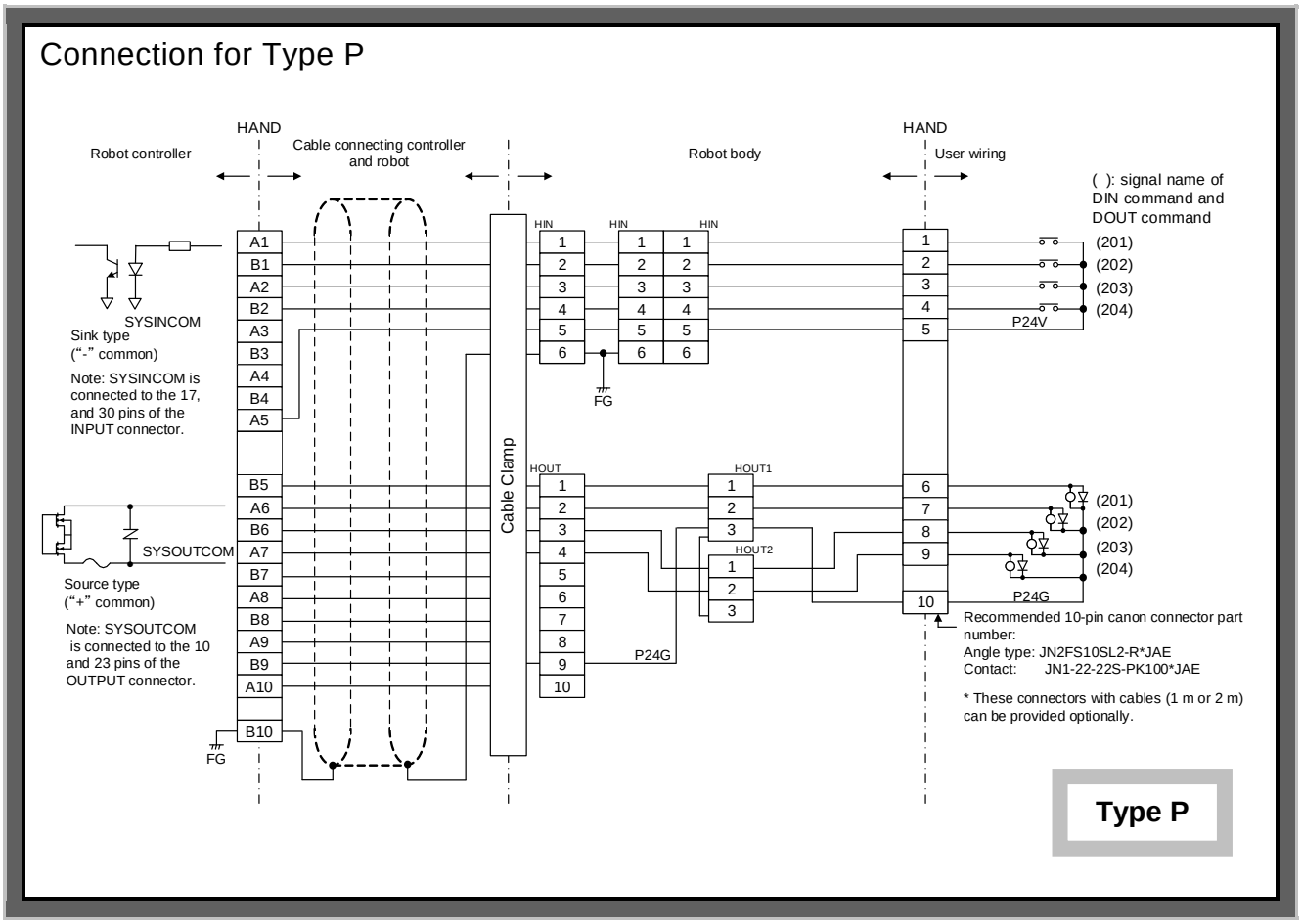


Fig. 3.10 Connection of hand I/O signal cable (Type P)

For details of the hand I/O cable connection, see the Installation and Transport Manual.

3.9 Fabricating Hand I/O Signal Cable

When fabricating a hand I/O signal cable, observe the following matters.
When using this function, use of exclusive cables (option) is recommended. For details, contact our after-sale service agent in your territory.

3.9.1 THL Series Hand

a. The CN0 connector on the robot side should be either the attached connector or equivalent connectors. The equivalent of other makers (D-sub connector) can also be used.

Connector name	Type of connector	Maker
CN0	XM3A–2521 (plug type connector)	OMRON
	XM2S–2511 (connector cover)	OMRON

b. Select the cables which meet the following specifications.

- Core wires : 0.18 mm^2 to 0.32 mm^2 twisted wires
- Cable outer diameter : Max. 10 mm
- Shield : Batch braided shield
- Cable length : 30 m or less

NEVER use cables which do not conform to the specifications. Otherwise, short-circuit or cable melting due to overheated cable core may be caused. Additionally, the robot may work improperly due to noise.

c. The CN0 connectors are of a solder cup type which joins cables by soldering. For how to join cables to connectors and how to shield cables, see Appendix 2.

3.9.2 TVL Series Hand

a. The HAND connector on the robot side should be equivalent connectors.

Connector name	Type of connector	Maker
HAND	JN2FS10SL2-R (plug angle type connector) JN1-22-22S-PKG100 (contact)	Japan Aviation Electronics Industry

b. Select the cables which meet the following specifications.

- Core wires : 0.2 mm^2 twisted wires
- Cable outer diameter : Max. 10 mm
- Shield : Batch braided shield
- Cable length : 30 m or less

NEVER use cables which do not conform to the specifications. Otherwise, short-circuit or cable melting due to overheated cable core may be caused. Additionally, the robot may work improperly due to noise.

3.10 Attaching and Detaching Hand I/O Signal Cable

Before attaching or detaching hand I/O signal cables to or from the robot, be sure to turn off the main power in the user's control panel.

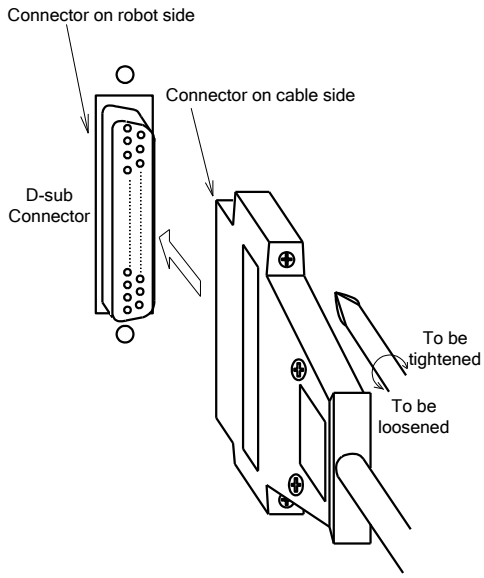


Fig. 3.11 Attaching and detaching hand I/O signal cable

To connect a hand I/O signal cable, completely insert the cable side connector into the robot side connector and tighten the lock screws on both sides of the connector with a screwdriver.
To disconnect the cable, loosen the lock screws, then pull out the connector. At this time, DO NOT pull the cable instead of the connector. Otherwise, an excessive force will be exerted on the cable, resulting in damage of the cable.

3.11 Hand I/O Signal

The hand I/O signals control the end effector such as hand attached to the robot. The connector used is CN0 which is located on the robot arm 2 for the SCARA robot. The TSL3000E/TSL3100E controller is provided with eight (8) input signals and eight (8) output signals to control the end effector. (Wiring from the motor drive power connections of the robot to the arm 2 is already finished before shipment. However, the number of input/output signals varies depending on the robot to be connected.)
The specifications of the input signal are the same as those of the digital input signal. (For the connection of the common wire, see Figs. 4.3 and 4.4)
All hand output signals turn off when the controller power is turned off or turned on. Therefore, the end effector should be designed so that a product will not drop from the hand at the time of power failure.
The hand I/O signals can be controlled by a program created with the robot language. In the robot language program, the hand I/O signals are specified by the signal name assigned to each signal.
For further information on the robot language, see the Robot Language Manual.

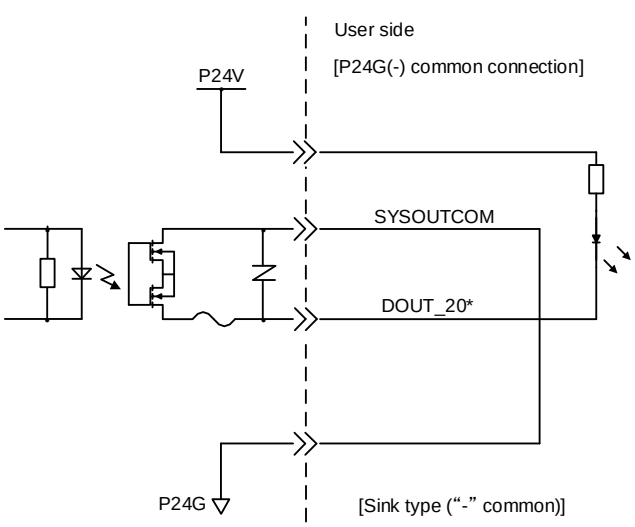
It is also possible to control a double solenoid device by combining two (2) hand output signals. When this happens, two (2) output signals bearing consecutive signal names are used for the double solenoid. Specify in the robot language program so that the two (2) output signals for the double solenoid can be exclusive during automatic operation. When the controller power is turned off and turned on, both output signals turn off.

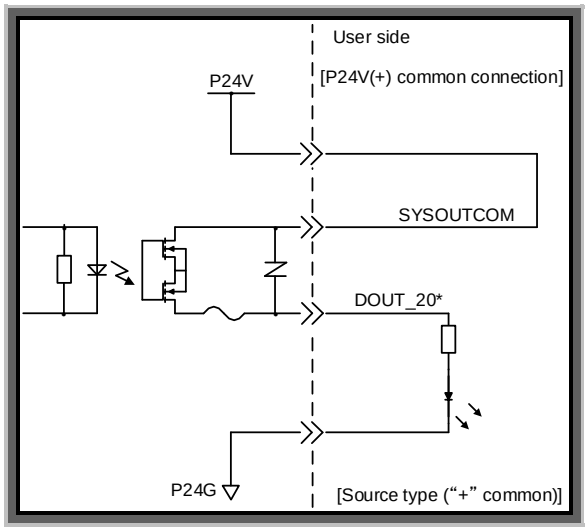
The hand output signals can be turned on and off manually through the teach pendant. For this purpose, hand output signals to be turned on and off should be defined by the "USER.PAR" (user parameter) beforehand.
For the parameter setting, see the User Parameter Manual.

Note: When the double solenoid is defined by the user parameter, two (2) hand output signals are output exclusively through the teach pendant. These two (2) output signals for the double solenoid should be programmed by the robot language, however, so that they can be exclusive during automatic operation. Also, even if the double solenoid is defined, both two (2) output signals turn off when the controller power is turned on.
In the commands of OPEN1, OPEN2, CLOSE1, CLOSE2, OPENI1, OPENI2, CLOSEI1 and CLOSEI2, each set of signals (201, 202) and (203, 204) is exclusively output.
The hand output signal cannot be reset by the RESET SIG or RESET DOUT command.

The specifications of the hand output signal are as follows:

- Output type: Photo MOS output
- Output circuit structure:





- Electric rating: Rated voltage 24 V DC
- Rated current: 100 mA (max.)

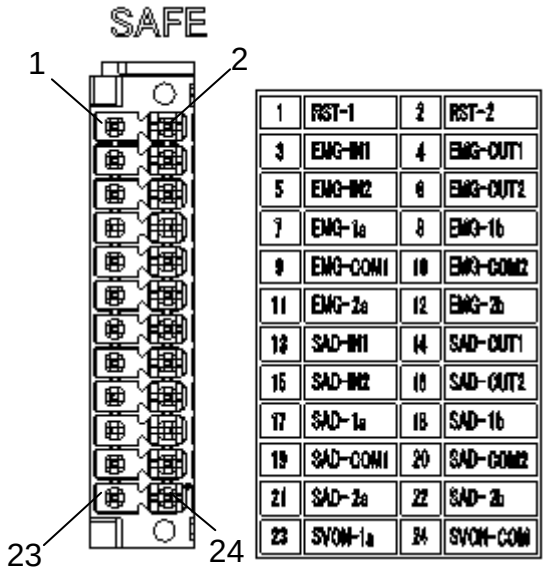
! **CAUTION**	If the current which exceeds the rated output current is supplied, the output device may be damaged or the printed board may be burnt. To avoid this, be sure to use within the rated output current. Amperage of eight (8) hand output signals should be 0.8 A or less. When using the hand I/O function, connect from the EXT I/O P24V supply cable of the controller front panel.

Section 4 External I/O Signal Cable

4.1 SAFE I/O Signal Cable

To use a customer's special system, use the attached connectors DFMC 1, 5/12-ST-3, 5-LR (plug type) for connecting the SAFE cable on the robot controller side. The connectors are the I/O connectors for contact inputs of the external emergency stop switch in the high-order system, safety door, etc. and for relay outputs that indicate the TSL3000E/TSL3100E controller status.

Detail of SAFE connector on controller front panel



1	RST-1	2	RST-2
3	EMG-IN1	4	EMG-OUT1
5	EMG-IN2	6	EMG-OUT2
7	EMG-1a	8	EMG-1b
9	EMG-COM1	10	EMG-COM2
11	EMG-2a	12	EMG-2b
13	SAD-IN1	14	SAD-OUT1
15	SAD-IN2	16	SAD-OUT2
17	SAD-1a	18	SAD-1b
19	SAD-COM1	20	SAD-COM2
21	SAD-2a	22	SAD-2b
23	SVON-1a	24	SVON-COM

4.2 Detail of SAFE Circuit

The connection diagram of the emergency stop switch is shown below.

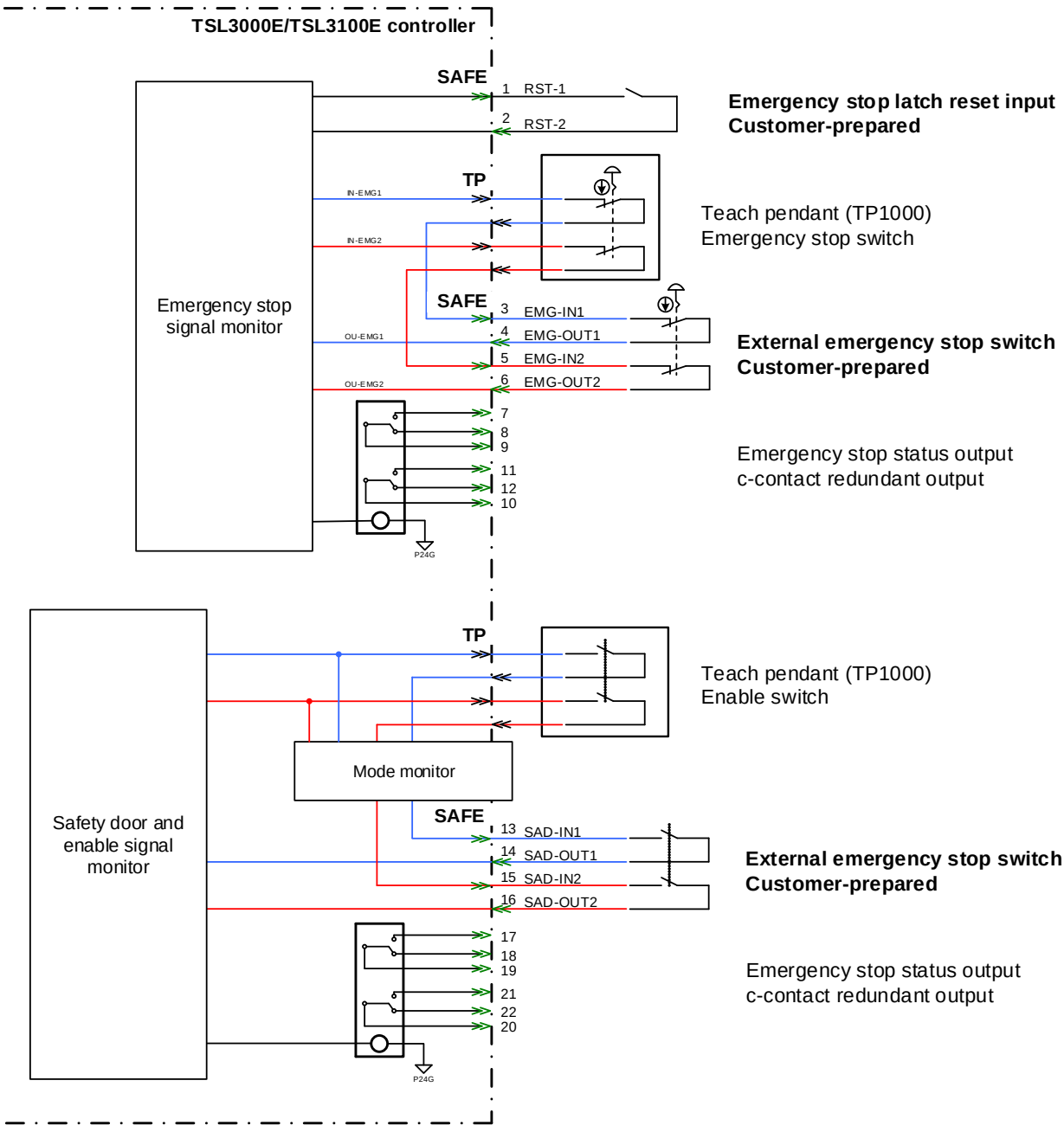


Fig. 4.1 Safety I/O circuit

4.3 Emergency Stop Input

To use the emergency stop switches externally, input two (2) b-contacts interconnected from the SAFE connector (between 2-3 and 5-6) on the controller front panel. If either of these signals is in open status, emergency stop status cannot be canceled. To restore from emergency stop status, place all connected emergency stop switches in close status. The controller enters servo ON enabled status without error indication by placing RST-1 and RST-2 in the same connector in short-circuited status (150 ms (min.)).

Independent dual-redundant c-contact outputs are provided to indicate controller status. Use these if the high-order sequencer is available and for the LED indicating the controller status.

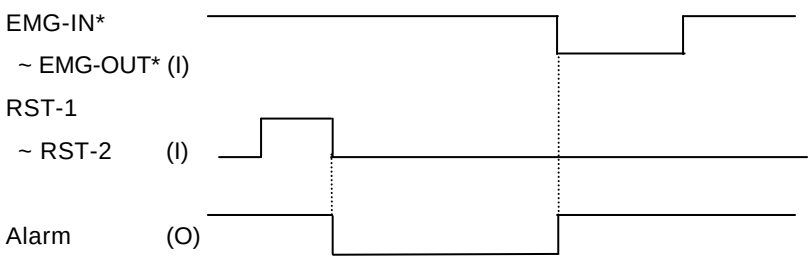
Relay output contact specification:

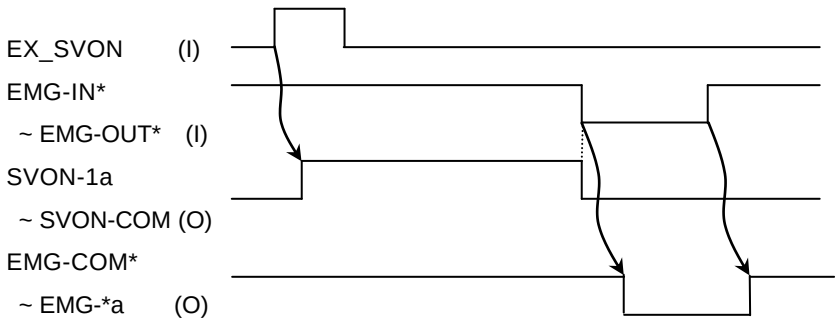
Maximum rating: 250 VAC, 6 A (max.)/125 VDC, 6 A (max.)

Notes on selection and placement of emergency stop switches

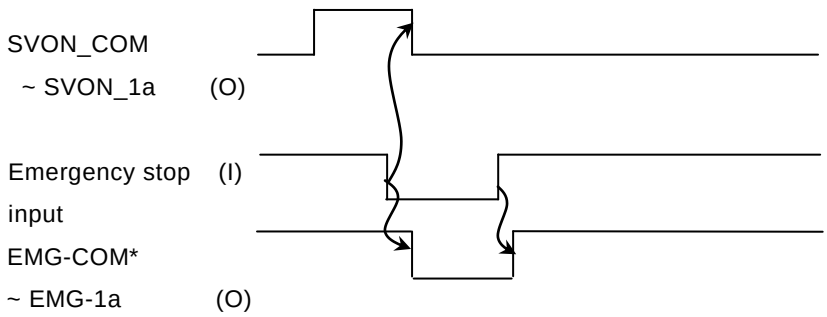
Note on the following when choosing and locating an emergency stop switch:

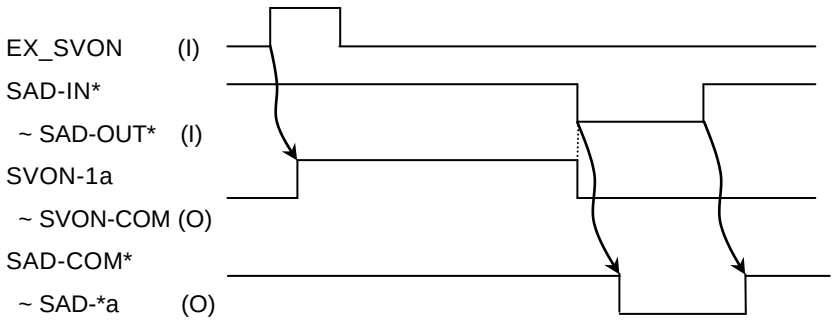
- Install an emergency stop device to the TSL3000E/TSL3100E and other locations where emergency stop is required. All the emergency stop devices must be placed where they can be easily accessed.
- Choose an emergency stop device which has such a structure that when the emergency stop device works, the circuit will not be automatically reset until the emergency stop device is reset manually and the contact will be reset only after the emergency stop device is reset.
- Choose any of the following shapes of emergency stop device that is suitable for the machine structure and characteristics so that unsafe conditions can be eliminated:
  1) Mushroom-type pushbutton
  2) Rope pull type, or bar type
  3) Belly or knee action type
  4) Pedal switch without a protective cover
- The pushbutton type of emergency stop device shall have a red actuator on a yellow background.
- The rope pull type of emergency stop device shall always maintain proper tension on the rope, and the rope shall be identified colored red and yellow.

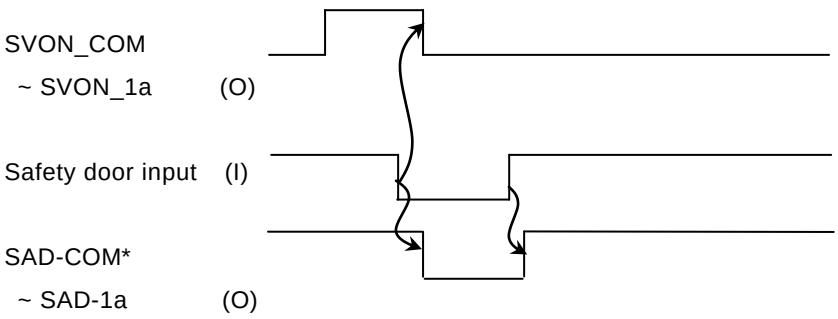
<table>
<tr><td>Designation</td><td>RST-1 to RST-2 (Reset inputs 1 and 2)</td></tr>
<tr><td>Input terminal</td><td>Between SAFE-1 and SAFE-2 (reset input for cancelling emergency stop latch)</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>Reset</td><td>Normal</td></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>The latch status of the safety relay module in the controller can be canceled by inputting reset signal from external equipment.
Be sure to input this signal after emergency stop processing is executed.
Be aware that the reset signal is accepted only while all emergency stop buttons are canceled.
Set the reset signal input width to 150 ms (min.).</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. This signal does not reset any alarm, but resets restoration from emergency stop latch status.
2. This signal operates at the falling edge. Even if short-circuited status is kept, no reset is performed.</td></tr>
</table>

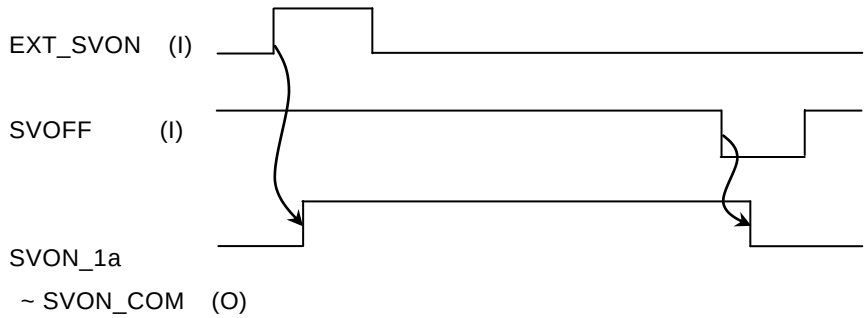
<table>
<tr><td>Designation</td><td>EMG-IN* ~ EMG-OUT*
(Emergency stop contact inputs 1 and 2)</td></tr>
<tr><td>Input terminal</td><td>Between SAFE-3 and SAFE-4
(emergency stop contact input 1)
Between SAFE-5 and SAFE-6
(emergency stop contact input 2)</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>Emergency stop</td><td>Normal</td></tr>
<tr><td>Open</td><td>○</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to emergency stop the robot from the external equipment.
While this signal is open, the processing of robot emergency stop is executed.
Use this signal by connecting the external emergency stop switch.
When the emergency stop input contact is open, emergency stop contact output is open between EMG-COM* and EMG-*a.
When emergency stop latch reset is input while emergency stop input contact is short-circuited, emergency stop contact output is short-circuited between EMG-COM* and EMG-*a.
Emergency stop contact output is c-contact. Use this signal in accordance with the customer’s specifications.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
</table>

Cautions	1. While this signal is open, the servo power cannot be turned on in any mode. 2. EMG-IN* to EMG-OUT* are assumed to have two (2) b-contacts interconnected, which should be turned on and off at the same time. If there is a delay in contact input operation, the non-conformity detection function of hardware works to retain emergency stop. If error clear is not done even after emergency stop latch input, confirm whether this signal has two (2) b inputs interconnected. 3. Unless this signal is used, short-circuit SAFE-3 to SAFE-4 and SAFE-5 to SAFE-6.

<table>
<tr><td>Designation</td><td>EMG-COM* ~ EMG-*a,EMG-*b
(Emergency stop contact outputs 1 and 2)</td></tr>
<tr><td>Input terminal</td><td>Between SAFE-9 and SAFE-7 and SAFE-8 pins
(c-contact output)
Between SAFE-10 and SAFE-11 and SAFE-12 pins
(c-contact output)</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Output terminal / Signal output</th><th>Open</th><th>Short-circuit</th></tr>
<tr><td>Emergency stop</td><td>EMG-COM* ~ EMG-*a</td><td>EMG-COM* ~ EMG-*b</td></tr>
<tr><td>Normal</td><td>EMG-COM* ~ EMG-*b</td><td>EMG-COM* ~ EMG-*a</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>While the EMERGENCY stop pushbutton switch provided on the teach pendant is pressed ON or emergency stop contacts 1 and 2 input from the external equipment are ON, the output terminals of this signal operate.
This signal can always be used regardless of the mode selected by means of the master mode switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>The signal is of a non-voltage contact output type. The logic is a c-contact output. The contact capacity is 250 VAC (max.), 6 A (max.)/125 VDC (max.), 6 A (max.).</td></tr>
</table>

<table>
<tr><td>Designation</td><td>SAD-IN* ~ SAD-OUT* (Safety door contact inputs 1 and 2)</td></tr>
<tr><td>Input terminal</td><td>Between SAD-13 and SAD-14 (safety door contact input 1)
Between SAD-13 and SAD-14 (safety door stop contact input 2)</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>Emergency stop</td><td>Normal</td></tr>
<tr><td>Open</td><td>○</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to emergency-stop the robot from the external equipment.
While this signal is open, the processing of robot emergency stop is executed.
Use this signal by connecting a safety device such as safety door switch, photoelectric type sensing safety device and safety mat switch.
When the emergency stop input contact is open, emergency stop contact output is short-circuited between SAD-COM* and SAD-*a.
Safety door contact output is c-contact. Use this signal in accordance with the customer’s specifications.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. While this signal is open, the servo power cannot be turned on in any mode.
2. SAD-IN* to SAD-OUT* are assumed to have two (2) b contacts interconnected, which should be turned on and off at the same time. If there is a delay in contact input operation, the non-conformity detection function of hardware works to retain emergency stop.
If error clear is not done even after emergency stop latch input, confirm whether this signal has two (2) b inputs interconnected.
3. Unless this signal is used, short-circuit SAFE-13 to SAFE-14 and SAFE-15 to SAFE-16.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>SAD-COM* ~ SAD-*a,SAD-*b
(Safety door contact outputs 1 and 2)</td></tr>
<tr><td>Input terminal</td><td>Between SAFE-19 and SAFE-17 and SAFE-18 pins
(c contact output)
Between SAFE-20 and SAFE-21 and SAFE-22 pins
(c contact output)</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Output terminal / Signal output</td><td>Open</td><td>Short-circuit</td></tr>
<tr><td>Emergency stop</td><td>SAD-COM* ~ EMG-*a</td><td>SAD-COM* ~ EMG-*b</td></tr>
<tr><td>Normal</td><td>SAD-COM* ~ SAD-*b</td><td>SAD-COM* ~ SAD-*a</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>While the enable switch provided on the teach pendant is pressed ON or safety door contacts 1 and 2 input from the external equipment are ON, the output terminals of this signal operate.
When the master mode switch is TEACH mode, the enable switch on the teach pendant becomes enabled and this signal can be operated.
When the master mode switch is EXT mode, the enable switch on the teach pendant becomes disabled.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>The signal is of a non-voltage contact output type. The logic is a c-contact output. The contact capacity is 250 VAC (max.), 6 A (max.)/125 VDC (max.), 6 A (max.).</td></tr>
</table>

<table>
<tr><td>Designation</td><td>SVON-1a ~ SVON_COM (Servo ON contact output)</td></tr>
<tr><td>Input terminal</td><td>Between SAFE-23 and SAFE-24 pins (contact output)</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Output terminal / Signal output</td><td>Open</td><td>Short-circuit</td></tr>
<tr><td>OFF</td><td>○</td><td></td></tr>
<tr><td>ON</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>While the servo power is turned on, the output terminals are short-circuited.
This signal can always be used regardless of the mode selected by means of the master mode switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>The signal is of a non-voltage contact output type. The logic is a a-contact output. The contact capacity is 250 VAC (max.), 6 A (max.)/125 VDC (max.), 6 A (max.).
It takes about two (2) seconds from the servo ON to the time when the robot is actually ready to work. Thus, it is necessary to program a delay of 2.5 seconds or over between the SV_RDY signal ON and the RUN signal ON.</td></tr>
</table>

4.4 Safety Door and Enable Input

To connect the safety door switch, etc. from external equipment, input the signals from the SAFE connector (between 13 and 14 and between 15 and 16) on the controller front panel. When either of these signals is open, emergency stop status cannot be canceled as with the emergency stop switch. To restore the system from the emergency stop status, place all connected safety door switches in close status. The controller enters normal status.
The operation of this signal from the teach pendant varies depending on the mode selected by means of the master mode switch on the controller front panel.
In TEACH mode, the enable switch on the teach pendant becomes enabled, and enters close status by gripping the switch to neutral.
In EXT mode, the enable switch on the teach pendant becomes disabled, but the safety door switch, etc. is enabled.

The operational correspondence is shown below.

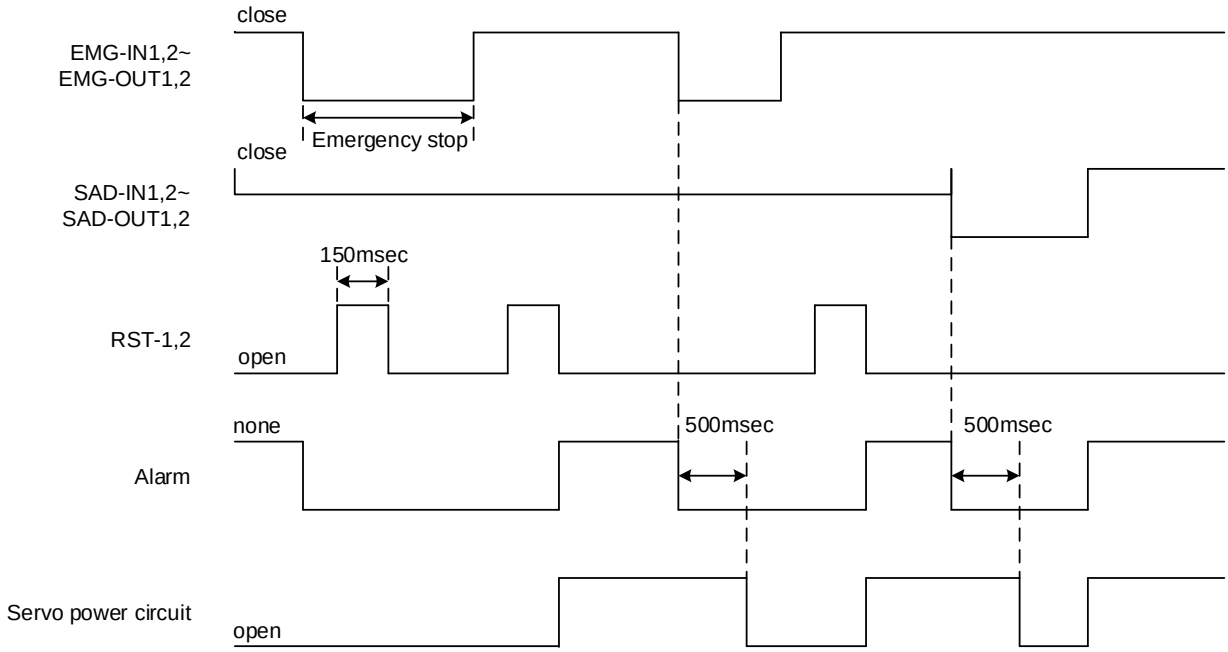
	Teach pendant enable switch	Safety door switch input	Emergency stop switch input	Speed limit
TEACH mode	Enabled	Enabled	Enabled	20%
EXT mode	Disabled	Enabled	Enabled	100%

Independent dual-redundant c-contact outputs are provided to indicate controller status. Use these if the high-order sequencer is available and for the LED indicating the controller status.

Relay output contact specification

Maximum rating: 250 VAC, 6 A (max.)/125 VDC, 6 A (max.)

4.5 SAFE Circuit Operation Timing



4.5.1 Start Method

While all emergency stop switches are canceled, the safety relay module in the controller is reset by pressing the switch between RST-1 and RST-2. Set the input width of RST-1 and RST-2 signals to 150 ms (min.) or more. When the safety relay module is reset, the alarm and servo power circuit enter close status and AC power is connected to the servo power unit.
Then, voltage charge is started and power is supplied to the motor by inputting the servo ON command signal.

4.5.2 Stop Method

The stop method varies depending on the status of the master mode switch on the control front panel.
In TEACH mode, when any of the emergency stop switch, enable switch on the teach pendant and safety input switch is open, slowdown and stop are started, the brake signal is then input, and the power to the motor is turned off. In EXT mode, the enable switch on the teach pendant is disabled, and the robot does not stop even if the enable switch on the teach pendant is gripped.
When a delay time of 500 ms elapses after any of the emergency stop switch, enable switch on the teach pendant and safety input switch is open, the servo power

circuit enters open status and the AC power to the servo power unit is turned off. The delay time of 500 ms is set by the safety relay module in the controller.

4.5.3 Restart Method

When the emergency stop switch is pressed, the safety relay module in the controller enters open status and error indication takes place. Be aware that servo ON enabled status is not entered.
If 088-014 Emergency Stop SW ON and 008-281 Emergency SW relay ON occur concurrently, the safety relay module for emergency stop switch is not reset. Press RST-1 and RST-2 signals while all emergency stop switches are canceled.
In TEACH mode, if the emergency stop switch is closed and the safety relay module is reset, the servo power circuit enters close status when the enable switch on the teach pendant is set to neutral.

4.6 Fabricating SAFE Signal Cable

Follow the points below when fabricating the external I/O signal cable.

a.) Use the connector supplied with the TSL3000E/TSL3100E robot controller for the SAFE connection connector.

Connector name	Type of connector	Maker
SAFE	DFMC 1,5 ST-3,5-LR (plug-type connector)	PHOENIX CONTACT

b.) Select the cable to be used based on the specifications below.

- Core wires: 1.0 mm^2 to 1.5 mm^2 (AWG18 to AWG16) twisted wire, single conductor
- Cable length: 30 m max.

Use of cables that do not match the specifications can result in a meltdown due to a short circuit or core wire overheating and also presents a danger of robot malfunction due to the intrusion of noise. Therefore, never use cables outside the specifications range.

c.) The SAFE connector is of type where the connectors are joined by connector lock. See Para. 4.7 "Attaching and Detaching SAFE Connector."

4.7 Attaching and Detaching SAFE Connector

Before attaching or detaching a safety I/O signal cable to or from the TSL3000E/TSL3100E robot controller, be sure to turn off the main power in the customer's control panel. Confirm that external P24V power is also turned off.

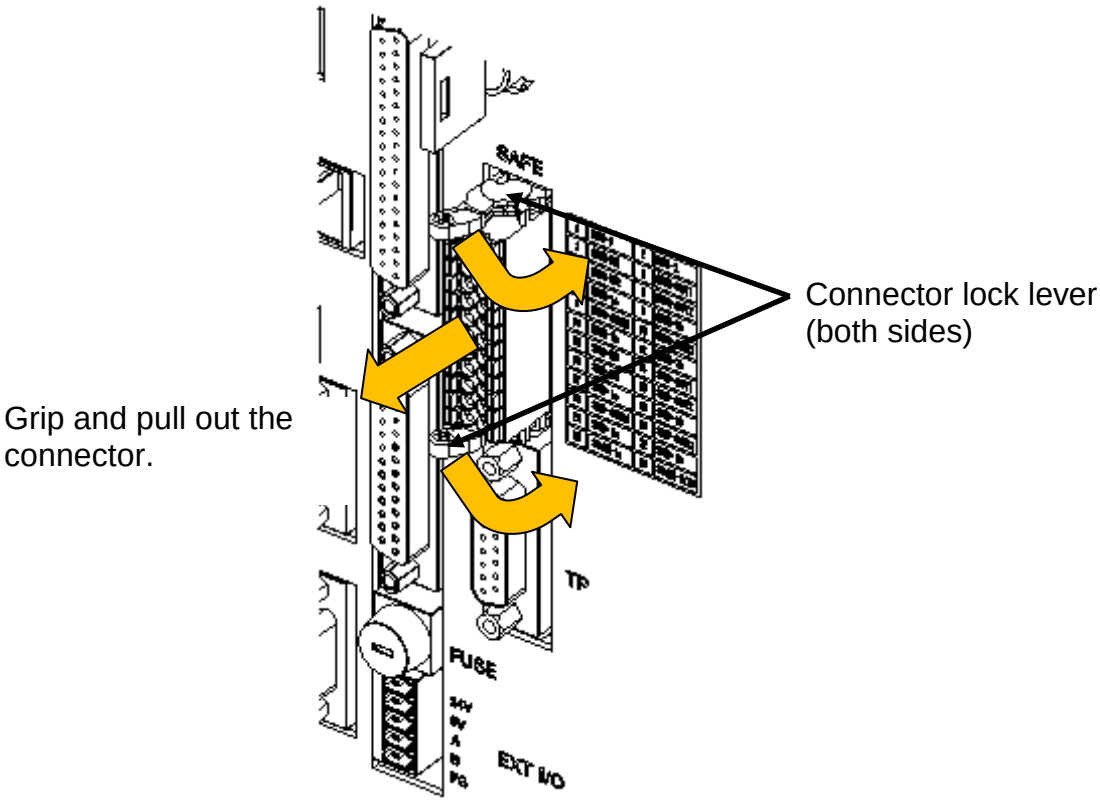


Fig. 4.2 Attaching and detaching safety I/O signal cable

To connect a safety I/O signal cable, completely insert the cable side connector into the controller side connector and lock them with the levers on both sides of the connector as shown in Fig. 4.2. To disconnect the cable, release the levers on both sides of the connector, then pull out the connector in reverse order of connection. At this time, DO NOT pull the cable instead of the connector. Otherwise, an excessive force will be exerted on the cable, resulting in loose cable connection.

! CAUTION

When attaching or detaching the cable, be sure to hold the connector rather than the cable.

4.8 External Input Signal Cable

4.8.1 Connection of External Input Signal Cable

To connect the external input signal cable, use the attached dummy connector [XM3A–3721 (plug type connector), XM2S–3711 (connector cover)]. Some system input signals (normal close contact) of this dummy connector are jumpered. Remove the jumpers, when necessary.
A cable with its single side soldered to the connector (TSL3000E/TSL3100E: INPUT cable) is provided optionally. Contact our after-sale service agent in your territory.

Connection for Type N

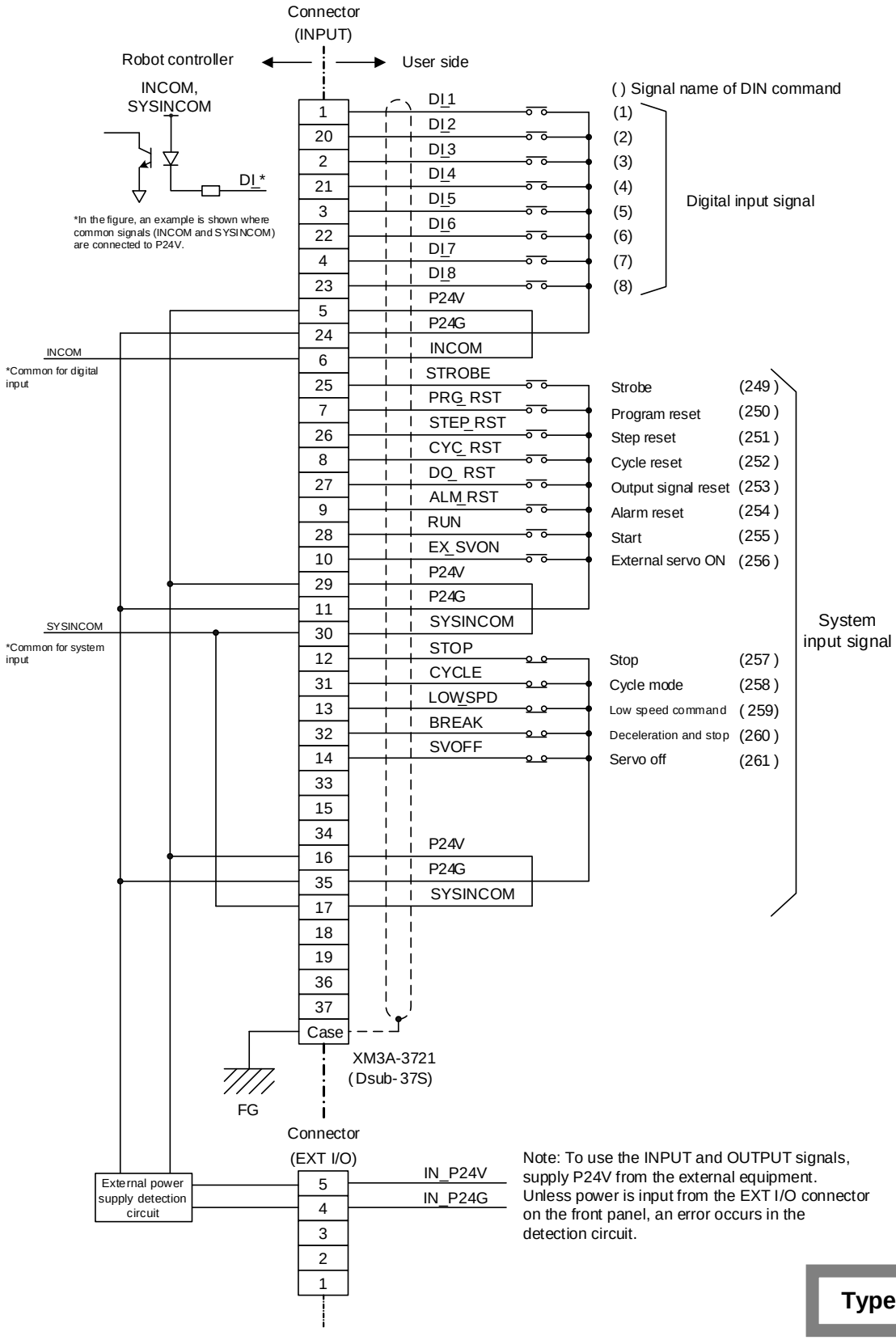


Fig. 4.3 Connection of external input signal cable (Type N)

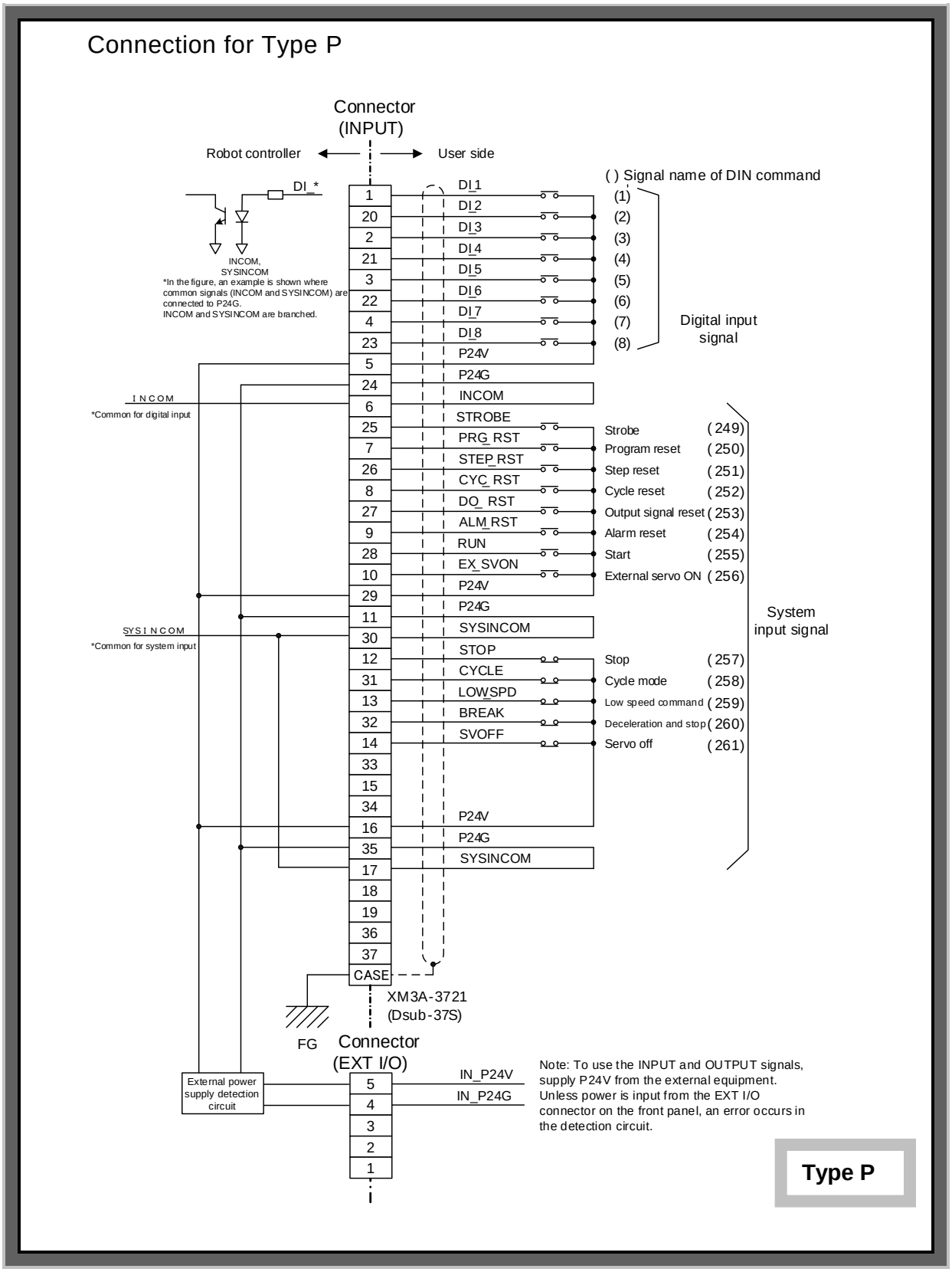
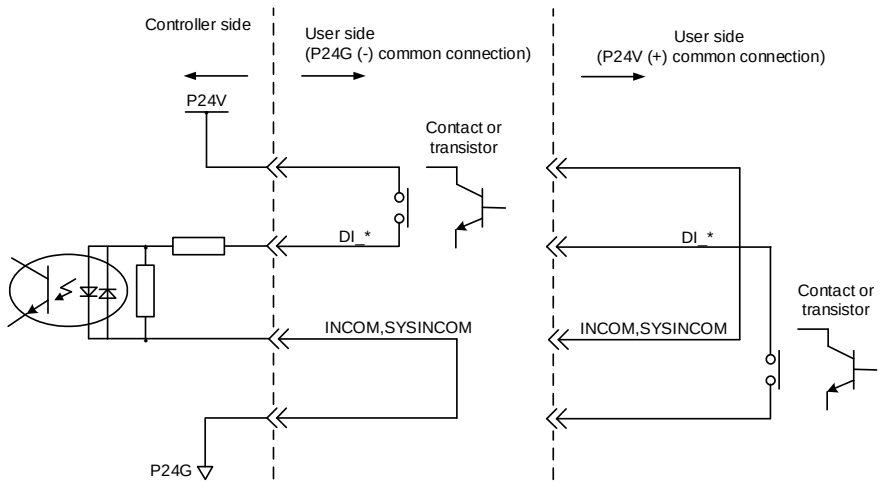
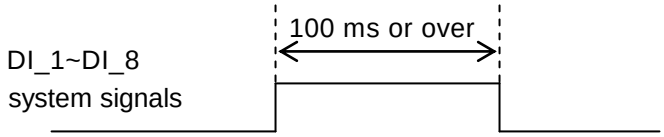


Fig. 4.4 Connection of external input signal cable (Type P)

As shown in Figs. 4.3 and 4.4 above, the external input signals are non-voltage contact inputs or open collector inputs. Some of the system inputs (STOP, CYCLE, LOW_SPD, BREAK, SVOFF) are normal close contact inputs, and the others are normal open contact inputs.
For the function, circuit to use, changeover of common wire, etc., see Para. 4.8.2.

4.8.2 Digital Input Signal

Designation	Digital input signal DI_1 ~ DI_8, system input signals
Connector input terminal	Digital input signals are assigned to INPUT-1 ~ 4 pins and 20 ~ 23 pins. The system input signals are assigned to INPUT-7 ~ 10 pins, 12~14 pins, 25~28 pins and 31~32 pins. Common wires for DI_1 to DI_8 are INCOM, and common wires for system input signal are SYSINCOM. For details of the connection, see the figure below (i.e., example of circuit).
Function	Each signal status of DI_1 ~ DI_8 can be identified by the robot program (DIN command) to branch the processing of program. Also, it is possible to perform interruptive processing of each signal (DI_1 ~ DI_8) with change in signal status monitored during the robot operation.
Input type	Non-voltage contact input or transistor open collector input.
Example of circuit (Input circuit structure)	
Signal logic	Input terminal — Signal judgment Open — OFF Short-circuit — ON

Specifications of non-voltage contact and transistor	• Non-voltage contact specifications Contact rating: 24 V DC, 10 mA or over Circuit current: Approx. 7 mA Minimum current: 24 V DC, 1 mA Contact impedance: 100 Ω or less • Transistor specifications Withstand voltage between collector and emitter: 30 V or over Current between collector and emitter: 10 mA or over Circuit current: Approx. 7 mA Leakage current between collector and emitter: 100 µA or less
Signal timing	When the pulse type input signals are used, the pulse width should be 100 ms or over. 

4.8.3 System Input Signal

A total of thirteen (13) system input signals are available, which control STOP, CYCLE, etc., sent from the external equipment to the TSL3000E/TSL3100E robot controller.
The system input signal is provided with an exclusive input terminal for each function.
The structure of the system input signal is quite the same as that of the digital input signal. See the descriptions in Para. 4.8.2.

When inputting the system input signal, keep the input status until the output signal corresponding to each input is output to assure each signal input. The relationship between input signal and output signal is stipulated by the timing chart of each signal. Also, each system input signal becomes enabled or disabled by means of the master mode switch equipped on the controller front panel. Each signal ON mode is shown in Table 4.1 below.

Table 4.1 List of system input signal ON modes

Master mode switch / Designation	ON mode		
	TEACH	EXT. SIGNAL	EXT. HOST
STROBE (Strobe)		○	
PRG_RST (Program reset)		○	
STEP_RST (Step reset)		○	
CYC_RST (Cycle reset)		○	
DO_RST (Output signal reset)		○	
ALM_RST (Alarm reset)		○	
RUN (Start)		○	
EX_SVON (External servo ON)		○	
STOP (Stop)	○	○	○
CYCLE (Cycle operation mode)		○	
LOW_SPD (Low speed command)	○	○	○
BREAK (Deceleration and stop)	○	○	○
SVOFF (Servo OFF)	○	○	○

○ : Available

CAUTION

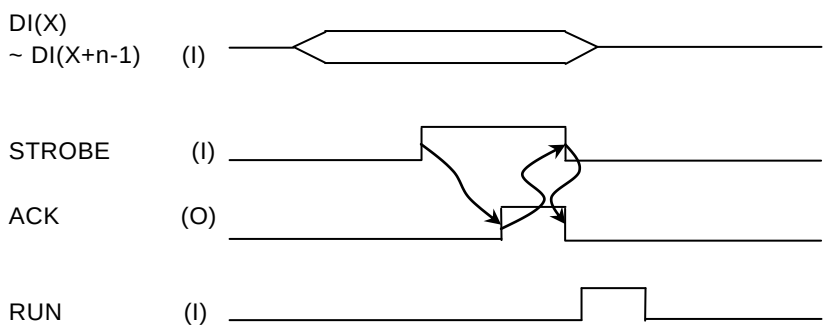
The control unit pushbutton to be attached to the robot controller must be manufactured and installed in a way that unexpected system startup can be prevented (e.g., attachment of a wrong operation prevention card).

CAUTION

If the system contains more than one controller, specify so that the robot can operate only when the same operation mode is selected for all the controllers. In addition, display the operation mode of each controller on the operation equipment.

Designation	STROBE (Strobe)
Input terminal	INPUT-25 pin
Signal name in DIN command	249
Signal logic	

Signal terminal \ Signal judgment	ON	OFF
Open		○
Short-circuit	○	

Function	Used to select an execution program for the TSL3000E/TSL3100E robot controller from the external equipment. The program number selected should use any successive "n" numbers (max. four (4) numbers) of external digital input signal, which are coded. 4 3 2 1 ← Program Number (max. four (4) bits) DI(X+n–1) --------- DI (X) ← External digital input signal * n = 1 ~ 4 For the program file name and register of it to the program number, and assignment of bits to external digital input signals, see the User Parameter Manual. This signal can be used only in the EXT. SIGNAL mode.
Signal timing	 With the start of the STROBE signal, the above digital signals are read to select an appropriate program. After the program has been selected, the ACK signal turns on. Turn on the RUN signal and execute the program.

Cautions	The STROBE signal should not be input together with the PRG_RST, CYC_RST, STEP_RST or DO_RST signal. Because the ACK signal is used in common, only the first signal which is input becomes valid and all other signals become invalid. If a file other than the current file is selected, the program is reset to step 1 and the values of variables are reset also.

* Program file name and register of it to program number, and assignment of bits to external digital input signals:

  To select an execution file (i.e., program selection), using digital input or extension input signals, assignment of bits to the controller input signals is necessary.

  User parameter [U07]
  [U07] Specify signal for EXTSELECT.
  {Signal No.} (1 –)
  {Bit length} (1 – 4)
  = 1 4

  Bits underlined = (Leading signal name in DIN command) (Bit length).
  "Signal name in DIN command" signifies an input signal number assigned in a program to run the internal sequence. (The signal name is predetermined in the program and cannot be changed by the user.)
  For the digital input signal, "signal name in DIN command" represents a number in parentheses as shown on the right side of the signal name in Fig. 4.3.

  (Leading signal name in DIN command):
  Specify the leading number of input signals to be used.
  (Allowable range: 1 ~ 8, 101 ~ 164)

  (Bit length):
  Specify the number of signals to be used. (Allowable range 1 ~ 4)

  Set value underlined (ex.) = 1 4
  This signifies that four (4) external digital input signals 1 ~ 4 are used.

Correspondence table
between [U07] set value (example) and [U08] program file name

Signal name in DIN command / Program file name (EXTRNSEL.PAR)	4	3	2	1
"PROG1"	0	0	0	0
"PROG2"	0	0	0	1
"PROG3"	0	0	1	0
"PROG4"	0	0	1	1
"PROG5"	0	1	0	0
"PROG6"	0	1	0	1
"PROG7"	0	1	1	0
"PROG8"	0	1	1	1
"PROG9"	1	0	0	0
"PROG10"	1	0	0	1
"PROG11"	1	0	1	0
"PROG12"	1	0	1	1
"PROG13"	1	1	0	0
"PROG14"	1	1	0	1
"PROG15"	1	1	1	0
"PROG16"	1	1	1	1

When bits underlined = 1 2, two (2) external digital input signals 1 and 2 are used, and the number of program files selected is four (4) from "PROG1" ~ "PROG4".

To register the program file name to the program number, register on the EXTRNSEL.PAR file.

EXTERNAL SELECT FILE
*** [00 - 0F] *****
= "PROG00"
= "PROG01"
= "PROG02"
= "PROG03"
= "PROG04"
= "PROG05"
= "PROG06"
= "PROG07"
= "PROG08"
= "PROG09"
= "PROG0A"
= "PROG0B"
= "PROG0C"
= "PROG0D"
= "PROG0E"
= "PROG0F"

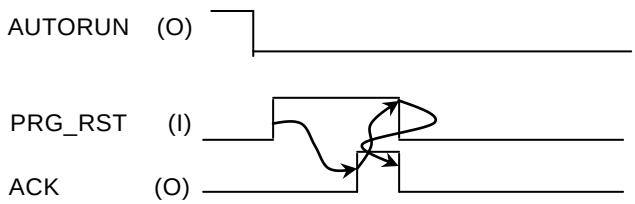
The initial setting is as shown above. Specify a file name you registered beforehand for the underlined of "PROG**".

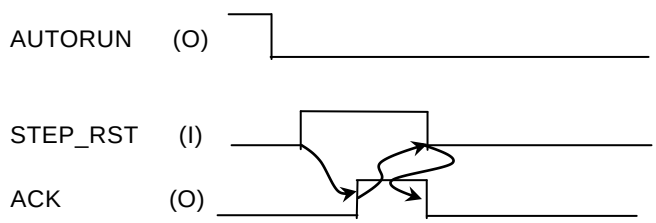
Example:

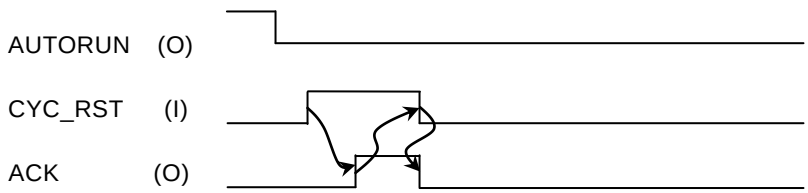
[U08] EXTSELECT file
= "AAA"
= "BBB"
= "CCC"
= "DDD"

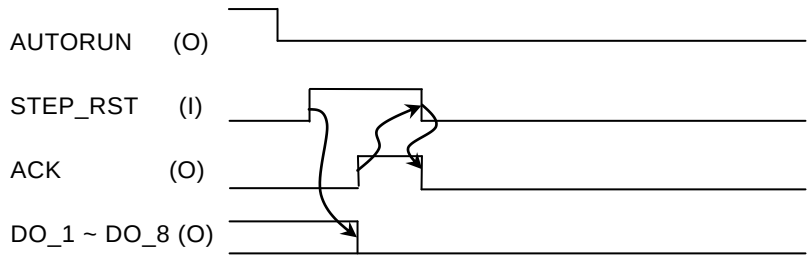
Specify the above program names in advance. Then specify zero (0) for both bits 1 and 2 of DIN command, which are set under [U07] (assume that [U07] = 1 2) and input the STROBE signal. Program "AAA" is automatically selected now. (If the following steps are taken without registering the program names, a "Compile Error" occurs.)

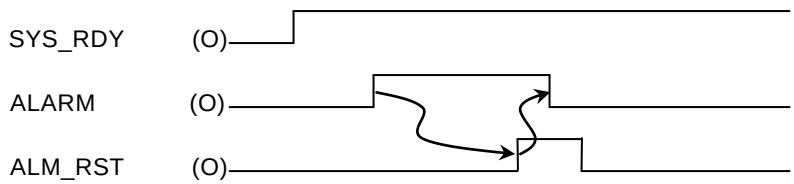
After the above parameter has been changed, save the data, turn the power off and on again. Otherwise, the parameter will not be operative.

Designation	PRG_RST (Program reset)
Input terminal	INPUT-7 pin
signal name in DIN command	250
Signal logic	<table><tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr><tr><td>Open</td><td></td><td>○</td></tr><tr><td>Short-circuit</td><td>○</td><td></td></tr></table>
Function	Used to reset a currently stopped program to step 1. The value of each variable is also reset to zero (0). This signal can be used only in the EXT. SIGNAL mode.
Signal timing	
Cautions	1. The PRG_RST signal should not be input together with the STROBE, CYC_RST, STEP_RST or DO_RST signal. Because the ACK signal is used in common, only the first signal which is input becomes valid and all other signals become invalid. 2. This signal cannot be used while AUTORUN (automatic operation mode ON) is set ON.

<table>
<tr><td>Designation</td><td>STEP_RST (Step reset)</td></tr>
<tr><td>Input terminal</td><td>INPUT-26 pin</td></tr>
<tr><td>signal name in DIN command</td><td>251</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to reset a currently stopped program to step 1.
The value of each variable used in the program remains unchanged.
This signal can be used only in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. The STEP_RST signal should not be input together with the STROBE, PRG_RST, CYC_RST or DO_RST signal. Because the ACK signal is used in common, only the first signal which is input becomes valid and all other signals become invalid.
2. This signal cannot be used while AUTORUN (automatic operation mode ON) is set ON.</td></tr>
</table>

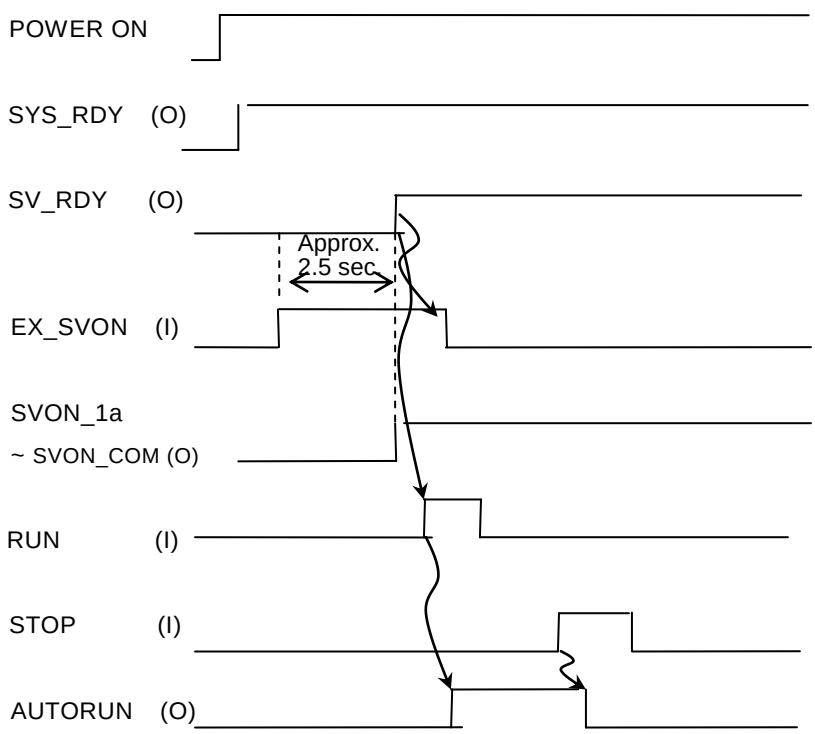
Designation	CYC_RST (Cycle reset)
Input terminal	INPUT-8 pin
Signal name in DIN command	252
Signal logic	<table><tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr><tr><td>Open</td><td></td><td>○</td></tr><tr><td>Short-circuit</td><td>○</td><td></td></tr></table>
Function	Used to reset a currently stopped program to the step labeled "RCYCLE". The value of each variable used in the program remains unchanged. This signal can be used only in the EXT. SIGNAL mode.
Signal timing	
Cautions	1. The CYC_RST signal should not be input together with the STROBE, PRG_RST, STEP_RST or DO_RST signal. Because the ACK signal is used in common, only the first signal which is input becomes valid and all other signals become invalid. 2. This signal cannot be used while AUTORUN (automatic operation mode ON) is set ON.

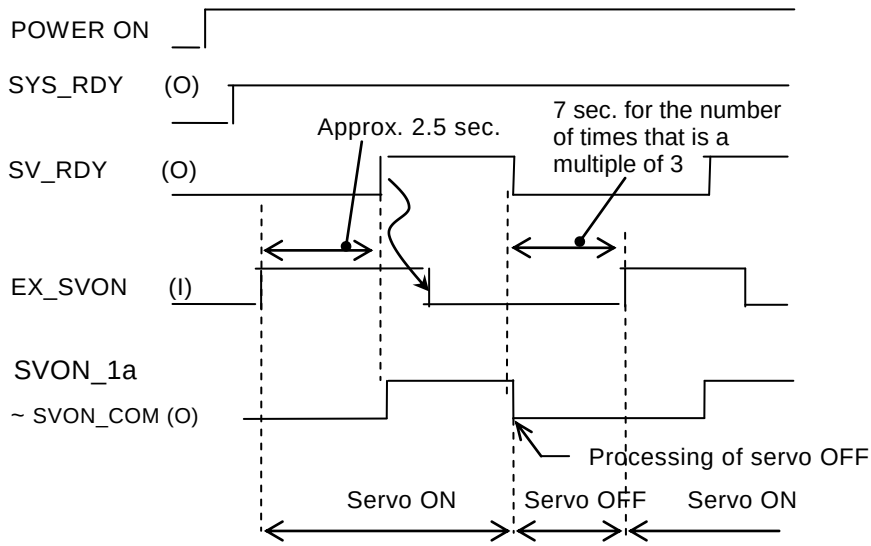
Designation	DO_RST (Output signal reset)
Input terminal	INPUT-27 pin
Signal name in DIN command	253
Signal logic	<table><tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr><tr><td>Open</td><td></td><td>○</td></tr><tr><td>Short-circuit</td><td>○</td><td></td></tr></table>
Function	Used to reset digital output signals (DO_1 ~ DO_8, DO_101 ~ DO_120, DO_133 ~ DO_152) of the TSL3000E/TSL3100E robot controller from the external equipment. When reset, all signals of DO_1 ~ DO_8 turn off. However, the system output signals are turned on. This signal can be used only in the EXT. SIGNAL mode.
Signal timing	
Cautions	1. The DO_RST signal should not be input together with the STROBE, PRG_RST, CYC_RST or STEP_RST signal. Because the ACK signal is used in common, only the first signal which is input becomes valid and all other signals become invalid. Neither system output signals nor hand output signals are reset. 2. This signal cannot be used while AUTORUN (automatic operation mode ON) is set ON.

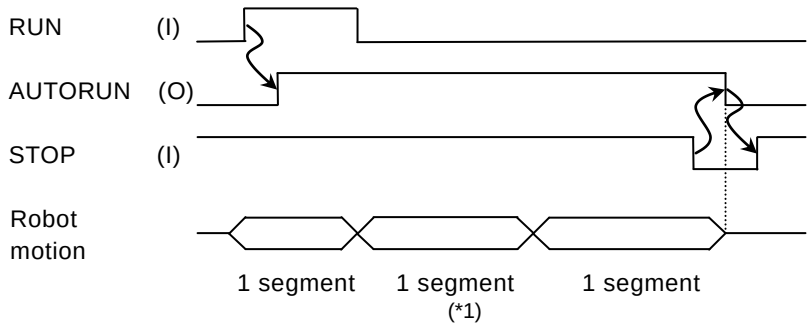
<table>
<tr><td>Designation</td><td>ALM_RST (Alarm reset)</td></tr>
<tr><td>Input terminal</td><td>INPUT-9 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>254</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to cancel an alarm from the external equipment, which occurred while the TSL3000E/TSL3100E robot controller was able to start.
This signal can be used only in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>If an alarm of the emergency stop level which will not allow the processing of EX_SVON, or EMG-COM* ~ EMG-*a, EMG-*b, SAD-COM* ~ SAD-*a or SAD-*b is output, alarm reset by the ALM_RST signal is not possible.</td></tr>
</table>

Designation	RUN (Start)
Input terminal	INPUT-28 pin
Signal name in DIN command	255
Signal logic	

Signal terminal \ Signal judgment	ON	OFF
Open		○
Short-circuit	○	

Function	Used to start a program registered in the TSL3000E/TSL3100E robot controller from the external equipment to execute an automatic cycle operation. This signal can be used only in the EXT. SIGNAL mode.
Signal timing	
Cautions	After servo ON, automatic operation starts with the start of the RUN signal. It takes about two (2) seconds from the input of EX_SVON to the time when the robot is actually ready to work. Thus, it is necessary to program a delay of 2.5 seconds or over between the SV_RDY signal ON and the RUN signal ON. If the RUN signal is input without a delay, it is neglected and the automatic operation is not started.

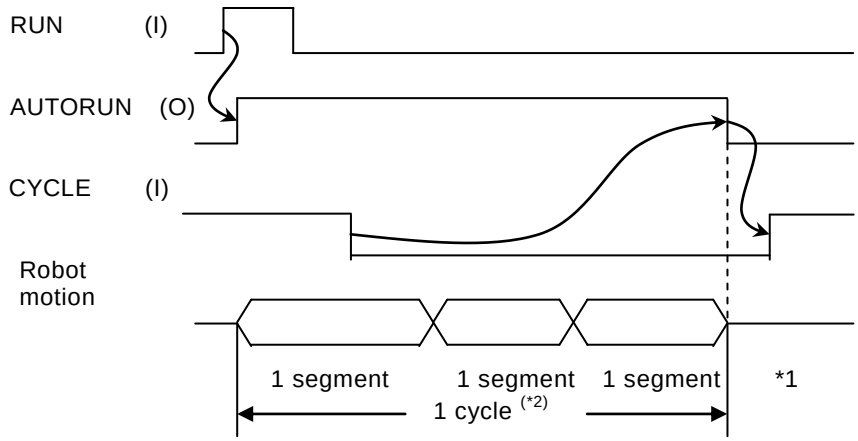
<table>
<tr><td>Designation</td><td>EX_SVON (External input servo ON)</td></tr>
<tr><td>Input terminal</td><td>INPUT-10 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>256</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td></td><td>○</td></tr>
<tr><td>Short-circuit</td><td>○</td><td></td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to turn on the servo driver main power from the external equipment. Once the servo power is turned on, it is maintained even after this signal turns off.
This signal can be used only in the EXT. SIGNAL mode.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>To prevent an internal damage after servo OFF, the interval time is seven (7) seconds when the servo is turned on for the number of times that is a multiple of 3.
If servo is to be turned on again for the first and second times, the EX_SVON signal can be accepted after the SV_RDY signal is turned off. However, be aware that an interval time is included in the third EX_SVON signal.</td></tr>
</table>

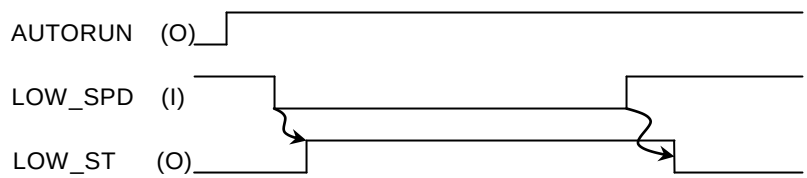
<table>
<tr><td>Designation</td><td>STOP (Stop)</td></tr>
<tr><td>Input terminal</td><td>INPUT-12 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>257</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td>○</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to stop executing a program registered in the TSL3000E/TSL3100E robot controller from the external equipment. When this signal is open, the program stops after the current motion command has been executed. When this signal is open, the robot cannot be operated. This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 

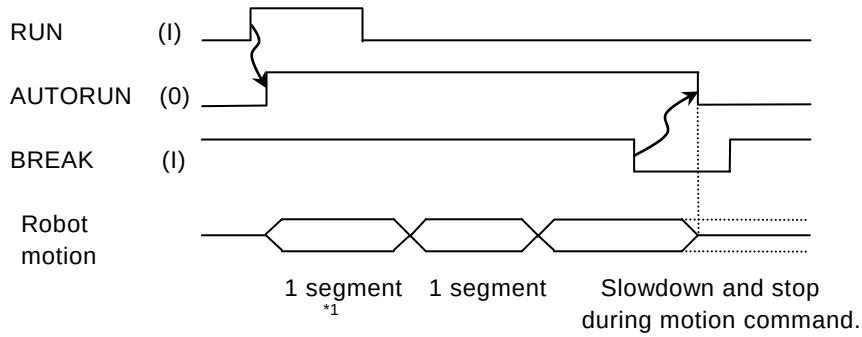
*1 Duration from the start of one motion command to just before the start of next motion command is called "1 segment".</td></tr>
<tr><td>Cautions</td><td>1. When the RUN command is executed after cancel of STOP, the program restarts from the step next to the interrupted step.
2. RUN signal input is ineffective at the input of STOP signal.
3. Unless this signal is used, short-circuit the INPUT-12 signal according to the common wire connection.</td></tr>
</table>

Designation	CYCLE (Cycle operation mode)
Input terminal	INPUT-31 pin
Signal name in DIN command	258
Signal logic	

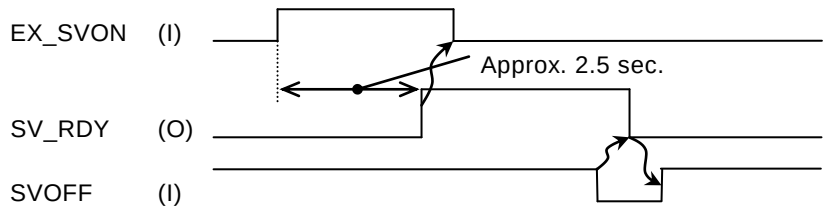
Signal terminal \ Signal judgment	ON	OFF
Open	○	
Short-circuit		○

Function	Used to stop from the external equipment a program registered in the TSL3000E/TSL3100E robot controller after current one (1) cycle operation has been executed during automatic operation. This signal can be used only in the EXT. SIGNAL mode.
Signal timing	 *1 Duration from the start of one motion command to just before the start of next motion command is called "1 segment". *2 Duration from the top of the main program to the END command is called "1 cycle".
Cautions	

<table>
<tr><td>Designation</td><td>LOW_SPD (Low speed command)</td></tr>
<tr><td>Input terminal</td><td>INPUT-13 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>259</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><th>Signal judgment / Signal terminal</th><th>ON</th><th>OFF</th></tr>
<tr><td>Open</td><td>○</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to cause the robot operation speed to low speed from the external equipment.
The robot operates at a low speed (the low speed command is valid) while this signal is open.
The robot operation speed in the low speed mode can be set by means of the parameter. (Initial set value: 25 %)
When this signal is short-circuited, the previously set value (initial set value: 100 %) takes effect again.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td></td></tr>
</table>

<table>
<tr><td>Designation</td><td>BREAK (Deceleration and stop)</td></tr>
<tr><td>Input terminal</td><td>INPUT-32 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>260</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>Open</td><td>○</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to stop the robot motion from the external equipment. The robot slows down and stops at the same time that this signal is open. After the stop, the robot enters a STOP (RETRY) status.
Even if this signal is short-circuited again after the stop of robot motion, the robot will not operate. To restart the robot, short-circuit this signal, then execute the RUN command.
If this signal is open, the robot cannot be started.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 

*1 Duration from the start of one motion command to just before the start of next motion command is called "1 segment".</td></tr>
<tr><td>Cautions</td><td>1. If the robot is operating, processing of execution is interrupted and the robot slows down and stops.
2. Unless this signal is used, short-circuit the INPUT-32 signal according to the common wire connection.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>SVOFF (Servo OFF)</td></tr>
<tr><td>Input terminal</td><td>INPUT-14 pin</td></tr>
<tr><td>Signal name in DIN command</td><td>261</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Signal terminal</td><td>ON
(Servo OFF)</td><td>OFF
(Normal)</td></tr>
<tr><td>Open</td><td>○</td><td></td></tr>
<tr><td>Short-circuit</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>Used to turn off the servo driver main power from the external equipment.
While this signal is open, the servo power is turned off.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. <u>While this signal is open, the servo power cannot be turned on in any mode.</u>
2. Unless this signal is used, short-circuit the INPUT-14 signal according to the common wire connection.</td></tr>
</table>

4.8.4 Jumper of Safety Measure Signal

Of the system input signal cables, the following signals are used for the safety measures.

System input signal cables	·····	INPUT-12	(STOP)
		INPUT-14	(SV_OFF)
		INPUT-32	(BREAK)
		INPUT-17, 35	(SYSINCOM ~ P24G)

For the dummy connector provided with the TSL3000E/TSL3100E robot controller, these signals are already jumpered. If these signals are used or changed, perform wiring with the jumper of connector removed. When operating the robot without using system input signals, be sure to connect the attached dummy connector to the INPUT connector on the controller side.
Unless the following signals are used as the external signals, jumper the cables also.

INPUT-13	(LOW_SPD)
INPUT-31	(CYCLE)

Jumper of connector [P24G(-) common is assumed.]

INPUT		
12–16	14–16	32–16
17-35	(13-16)	(31-16)

! **CAUTION**	• Unless the signals of SVOFF and emergency stop contact inputs 1 and 2 and safety door contact inputs 1 and 2 are closed, the controller servo power cannot be turned on. • If the CYCLE signal is not connected by a jumper, the controller runs in cycle operation mode. • If the LOW_SPD signal is not connected by a jumper, the robot automatic operation speed is low speed. • If the STOP signal is not connected by a jumper, robot automatic operation is not performed. • If the BREAK signal is not connected by a jumper, robot automatic operation is not performed.

4.9 External Output Signal Cable

4.9.1 Connection of External Output Signal Cable

To connect the external output signal cable, use the attached connector [XM3A–2521 (plug type connector), XM2S–2511 (connector cover)].
A cable with its single side soldered to the connector (TSL3000E/TSL3100E: OUTPUT cable) is provided optionally. Contact our after-sale service agent in your territory.

Connection for Type N

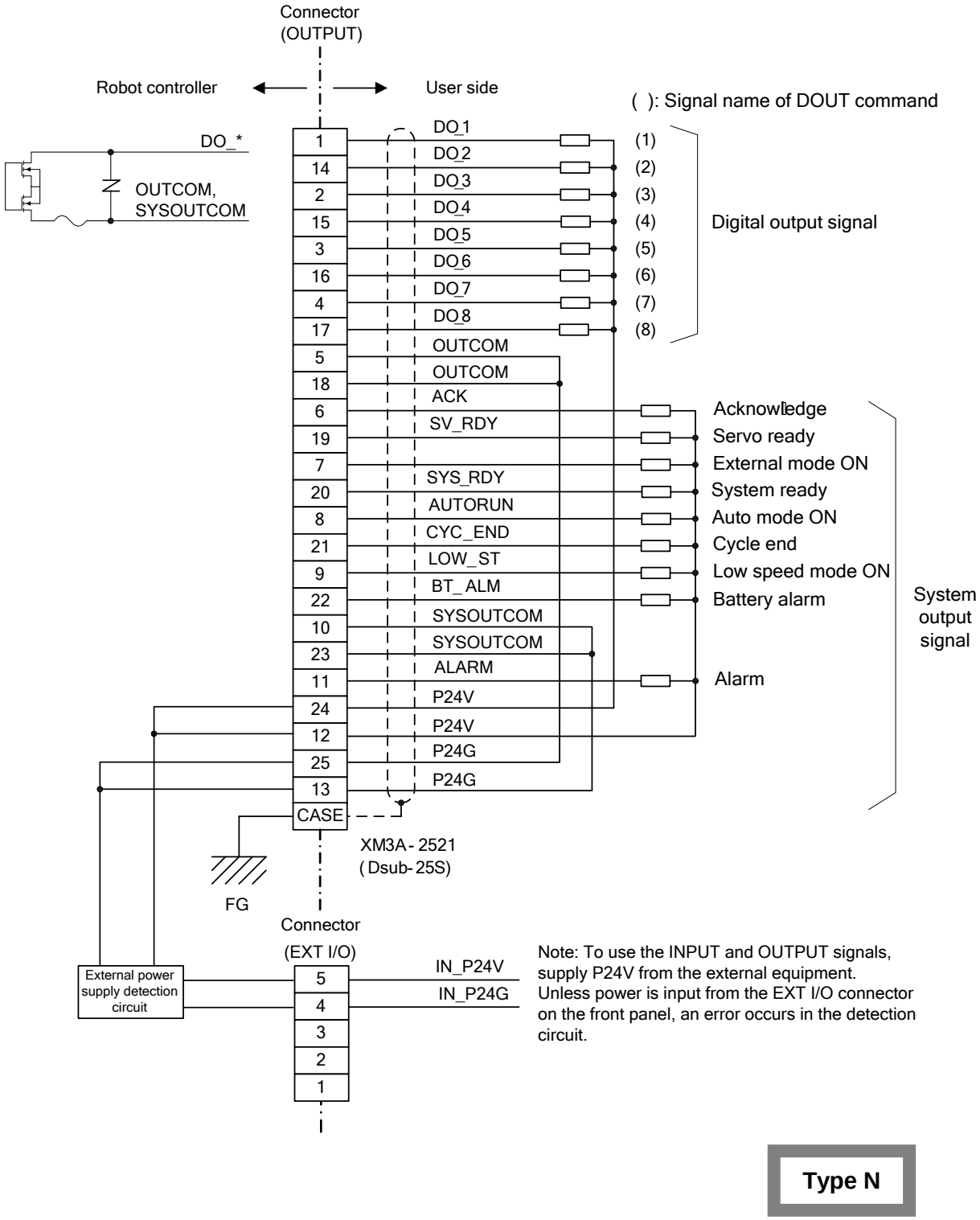


Fig. 4.5 Connection of external output signal cable (Type N)

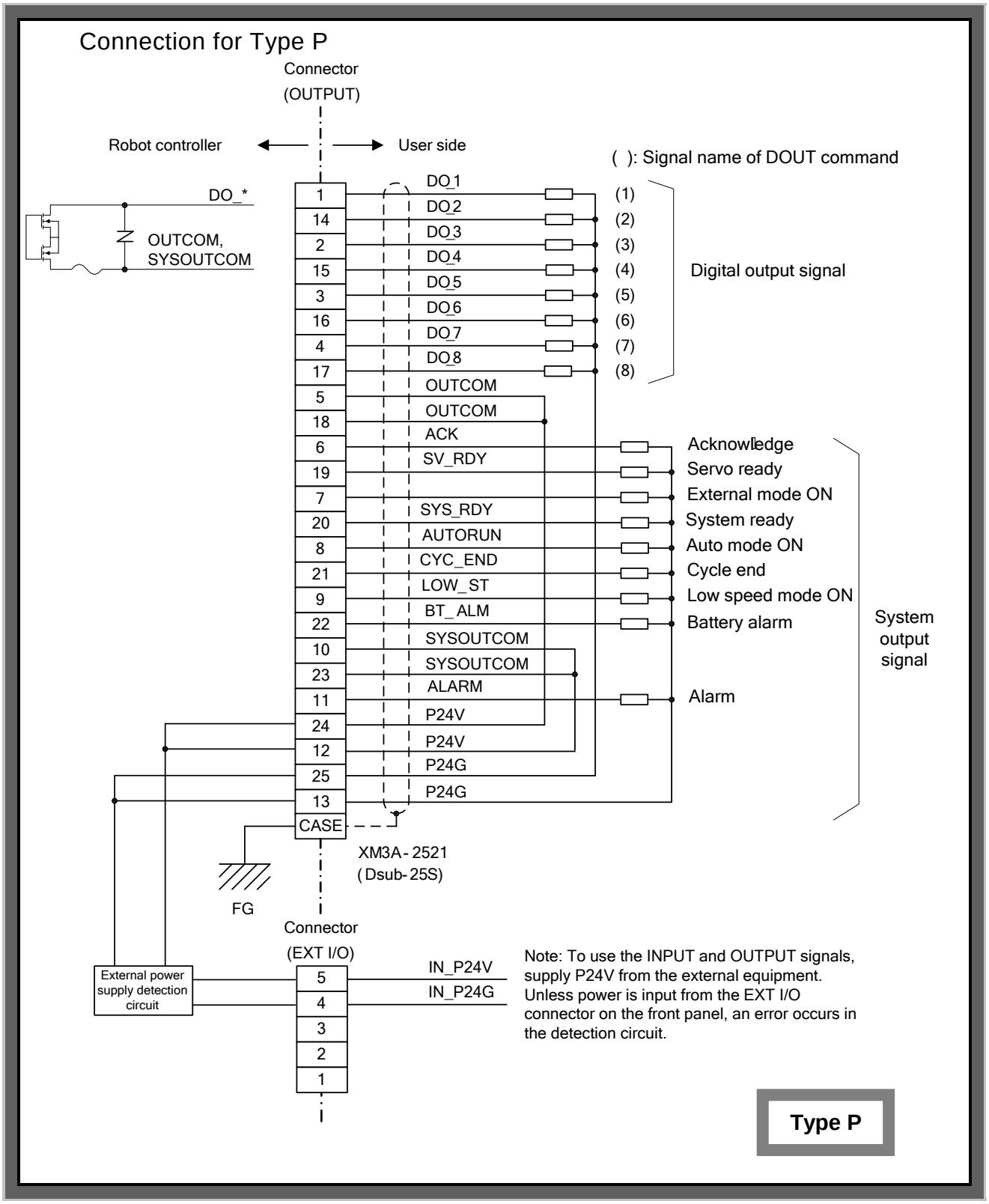
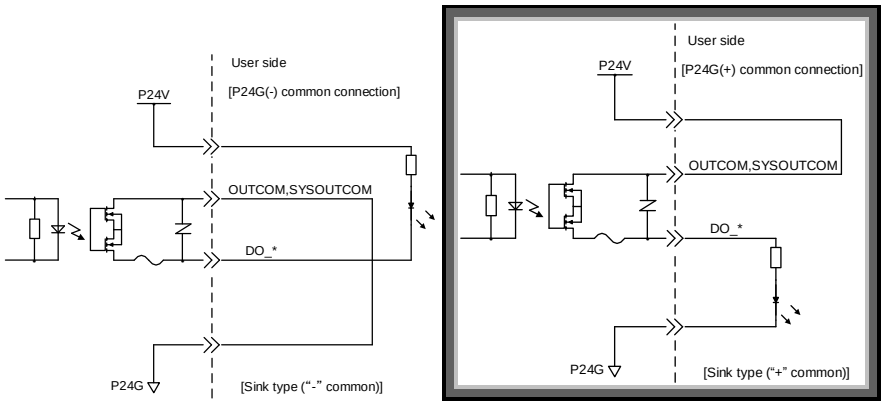
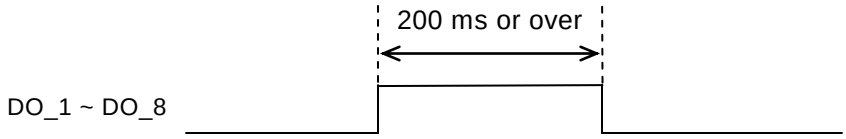


Fig. 4.6 Connection of external output signal cable (Type P)

As shown in Figs. 4.5 and 4.6 above, all seventeen (17) digital output signals are photo MOS outputs.
For the function, circuit to use, etc., see Para. 4.9.2.
External output can be controlled by the TSL3000E/TSL3100E internal sequencer. For details, see the Simplified PLC Manual.

4.9.2 Digital Output Signal

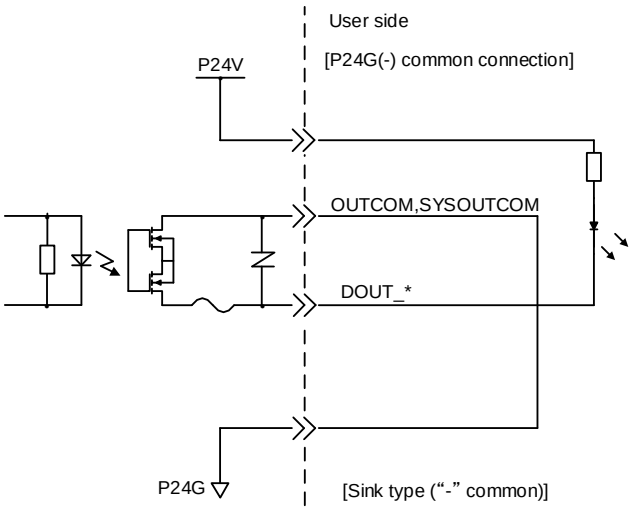
Designation	Digital output signal DO_1 ~ DO_8 (system output signals)
Connector output terminal	Digital output signals are assigned to OUTPUT-1 ~ 4 pins and 14 ~ 17 pins. (See Figs. 4.5 and 4.6.) The system output signals are assigned to OUTPUT-6 ~ 9 pins, 11 pin, and 19 ~ 22 pins.
Function	ON/OFF of signals DO_1 ~ DO_8 and pulse output can be performed by the robot program (BCDOUT command and PULOUT command).
Output type	Photo MOS output (bi-direction)
Example of circuit Output circuit structure	
Electric rating	Rated voltage: 24 V DC Rated current: 50 mA (max.) **Caution:** If the current which exceeds the rated output current is supplied, the output device may be damaged or the printed board may be burnt. To avoid this, be sure to use within the rated output current.
Signal timing	When performing pulse output by the PULOUT command, the output pulse width should be 200 ms or over. 

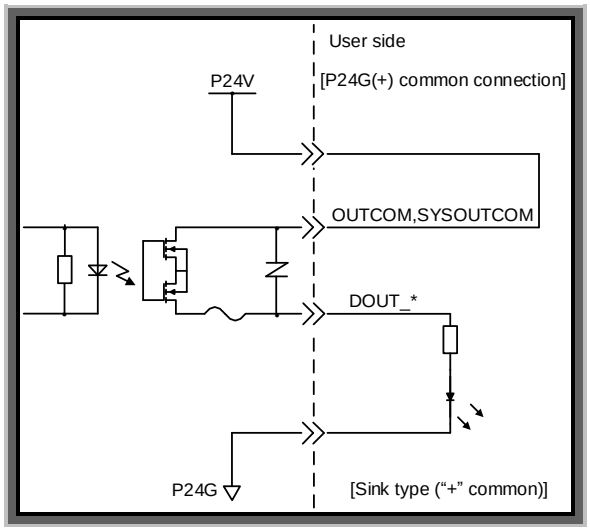
4.9.3 System Output Signal

Nine (9) signals are used to output the run status of the TSL3000E/TSL3100E robot controller.
The system output signal is provided with an exclusive output terminal for each function.
The specifications of the system output signals are as follows:

- Output type
  Photo MOS output (bi-direction)

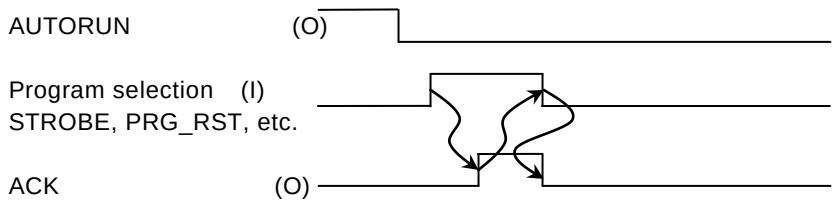
- Output circuit structure

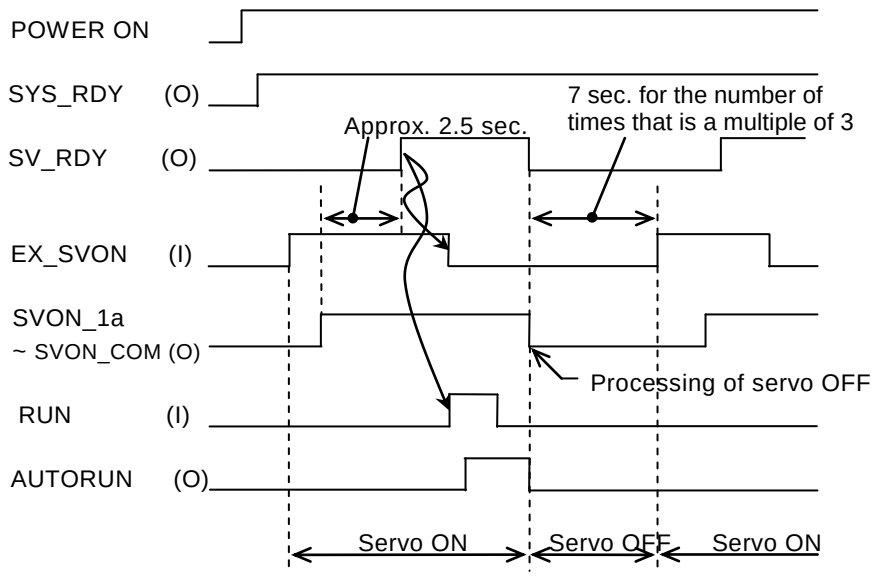


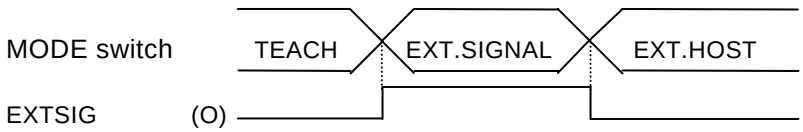


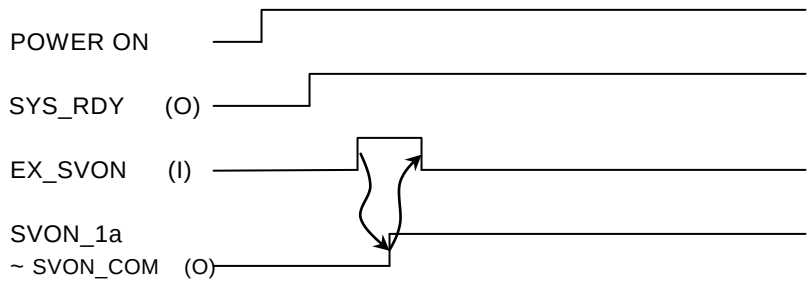
- Photo MOS specification
  Rated voltage: 24 V DC
  Rated current: 50 mA max.

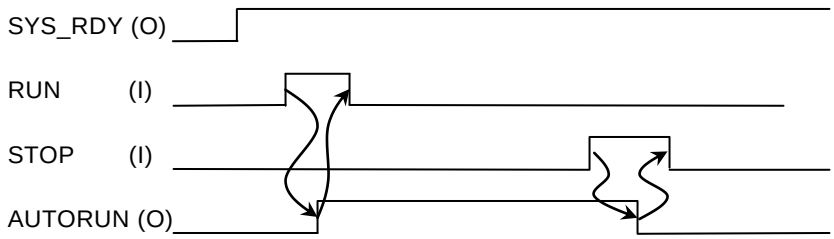
! **CAUTION**	If the current which exceeds the rated output current is supplied, the output device may be damaged or the printed board may be burnt. To avoid this, be sure to use within the rated output current.

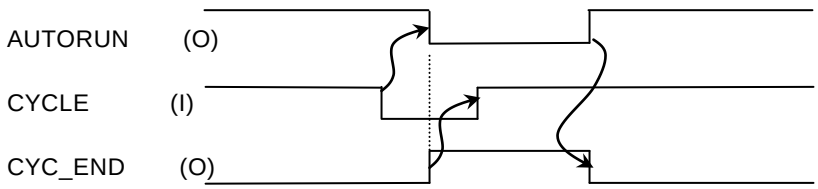
<table>
<tr><td>Designation</td><td>ACK (Acknowledge)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-6 pin</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment
Output terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>High</td><td>O</td><td></td></tr>
<tr><td>Low</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This is a response signal to the STROBE, PRG_RST, STEP_RST, CYC_RST and DO_RST signals. When one of these signals is input, the ACK signal is sent back to inform that appropriate processing has finished.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>If two (2) or more input signals shown above are input at the same time, only the signal which was input first is processed, then the ACK signal is output.</td></tr>
</table>

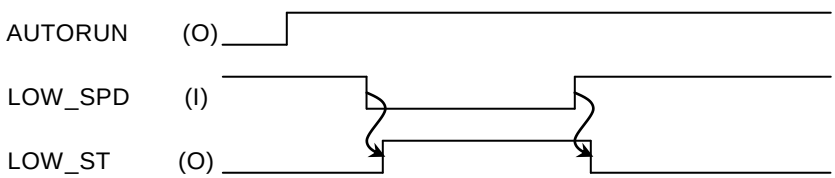
Designation	SV_RDY (Servo ready)
Output terminal	OUTPUT-19 pin
Signal logic	<table><tr><th>Signal judgment / Output terminal</th><th>ON</th><th>OFF</th></tr><tr><td>High</td><td>○</td><td></td></tr><tr><td>Low</td><td></td><td>○</td></tr></table>
Function	This signal indicates that the servo power of the TSL3000E/TSL3100E robot controller can be turned on. This signal can always be used, irrespective of the master mode selected by means of the MODE switch.
Signal timing	
Cautions	1. Program so that the RUN signal can be turned on only after the SV_RDY signal turns on. 2. To prevent an internal damage after servo OFF, the interval time is seven (7) seconds when the servo is turned on for the number of times that is a multiple of 3. If servo is to be turned on again for the first and second times, the EX_SVON signal can be accepted after the SV_RDY signal is turned off. However, be aware that an interval time is included in the third EX_SVON signal.

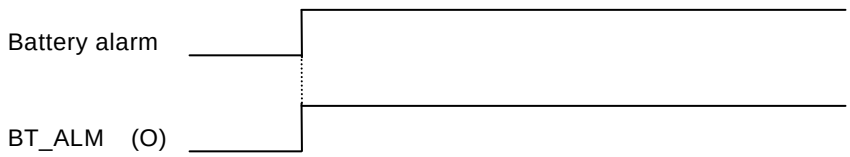
Designation	EXTSIG (External mode ON)
Output terminal	OUTPUT-7 pin
Signal logic	<table><tr><th>Signal judgment / Output terminal</th><th>ON</th><th>OFF</th></tr><tr><td>High</td><td>O</td><td></td></tr><tr><td>Low</td><td></td><td>O</td></tr></table>
Function	This signal turns on when the MODE switch of the TSL3000E/TSL3100E robot controller is set to "EXT. SIGNAL".
Signal timing	
Cautions	When the EXT. SIGNAL mode is selected by means of the MODE switch, all system input signals become operative.

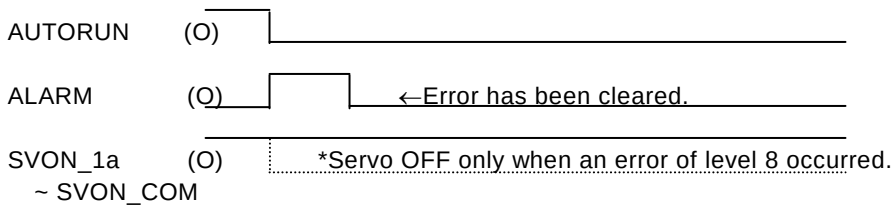
<table>
<tr><td>Designation</td><td>SYS_RDY (System ready)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-20 pin</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Output terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>High</td><td>O</td><td></td></tr>
<tr><td>Low</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on when the robot can start after the controller main power is turned on.
With this signal, it is possible to confirm that the robot can be operated.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td></td></tr>
</table>

<table>
<tr><td>Designation</td><td>AUTORUN (Auto mode ON)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-8 pin</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Output terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>High</td><td>○</td><td></td></tr>
<tr><td>Low</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on when the robot is operating in the automatic operation mode.
When the RUN signal is made valid after the SYS_RDY signal is turned on, automatic operation starts with this signal output.
This signal remains on as long as the robot is operating in the automatic operation mode.
This signal turns on when the EXT. SIGNAL or EXT. HOST mod is selected by means of the MODE switch of the TSL3000E/TSL3100E robot controller.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>This signal will not turn on while the TEACH mode is selected by means of the MODE switch of the TSL3000E/TSL3100E robot controller.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>CYC_END (Cycle end)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-21 pin</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Output terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>High</td><td>○</td><td></td></tr>
<tr><td>Low</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on after the stop of 1-cycle automatic operation only when the CYCLE signal is made valid in the program execution (RUN) mode and an automatic operation is executed.
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>1. This signal turns off when the RUN mode takes effect.
2. This signal turns on also when the cycle operation has been stopped by the STOP, BREAK or ALARM signal.</td></tr>
</table>

<table>
<tr><td>Designation</td><td>LOW_ST (Low speed mode ON)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-9 pin</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Output terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>High</td><td>○</td><td></td></tr>
<tr><td>Low</td><td></td><td>○</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on while the robot is operating in the low speed mode by the input of system input signal LOW_SPD. This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td></td></tr>
</table>

<table>
<tr><td>Designation</td><td>BT_ALM (Battery alarm)</td></tr>
<tr><td>Output terminal</td><td>OUTPUT-22 pin</td></tr>
<tr><td>Signal logic</td><td>
<table>
<tr><td>Signal judgment / Output terminal</td><td>ON</td><td>OFF</td></tr>
<tr><td>High</td><td>O</td><td></td></tr>
<tr><td>Low</td><td></td><td>O</td></tr>
</table>
</td></tr>
<tr><td>Function</td><td>This signal turns on if a battery alarm has occurred in the robot or robot controller.
The battery alarm detects all encoders of axis 1 to axis 4 and axis 6 and battery level in the main control board (X8YV).
This signal can always be used, irrespective of the master mode selected by means of the MODE switch.</td></tr>
<tr><td>Signal timing</td><td> 
</td></tr>
<tr><td>Cautions</td><td>If the battery alarm has occurred, replace the battery immediately by identifying a battery whose voltage has dropped according to the alarm code indicated as an error and referring to the Instruction Manual: Maintenance.</td></tr>
</table>

Designation	ALARM (Alarm)
Output terminal	OUTPUT-11 pin
Signal logic	<table><tr><td>Signal judgment / Output terminal</td><td>ON</td><td>OFF</td></tr><tr><td>High</td><td>○</td><td></td></tr><tr><td>Low</td><td></td><td>○</td></tr></table>
Function	This signal turns on if an error of level 2, 4 or 8 has occurred in the robot or TSL3000E/TSL3100E robot controller. This signal is kept ON during error detection and turns off after the error has been cleared. For details on the errors, see the Operator's Manual. This signal can always be used, irrespective of the master mode selected by means of the MODE switch.
Signal timing	
Cautions	

4.10 Fabricating External I/O Signal Cable

When fabricating an external I/O signal cable, observe the following matters.

a.) Connectors INPUT and OUTPUT for the TSL3000E/TSL3100E robot controller should be either the connectors attached to the controller or equivalent connectors.
The equivalent of other makers (D-sub connectors) can also be used.

Connector name	Type of connector	Maker
INPUT	XM3A–3721 (plug type connector) XM2S–3711 (connector cover)	OMRON
OUTPUT	XM3A–2521 (plug type connector) XM2S–2511 (connector cover)	

b.) Select the cables which meet the following specifications.

- Core wires : 0.18 mm^2 to 0.32 mm^2 twisted wires
- Cable outer diameter : Max. 13 mm (INPUT), 11 mm (OUTPUT)
- Shield : Batch braided shield
- Cable length : 30 m or less

NEVER use cables which do not conform to the specifications. Otherwise, short-circuit or cable melting due to overheated cable core may be caused. Additionally, the robot may work improperly due to noise.

c.) The INPUT and OUTPUT connectors are of a solder cup type which joins cables by soldering. For how to join cables to connectors and how to shield cables, see Appendix 2.

* Cables with their single side soldered to the connector (TSL3000E/TSL3100E: INPUT/OUTPUT cables) are provided optionally. (We can advise of the cable length.) Contact our after-sale service agent in your territory.

4.11 Attaching and Detaching External I/O Signal Cable

Before attaching or detaching an external I/O signal cable to or from the TSL3000E/TSL3100E robot controller, be sure to turn off the main power in the user's control panel.

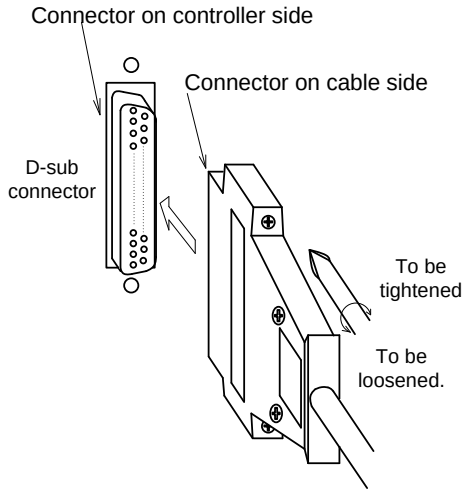


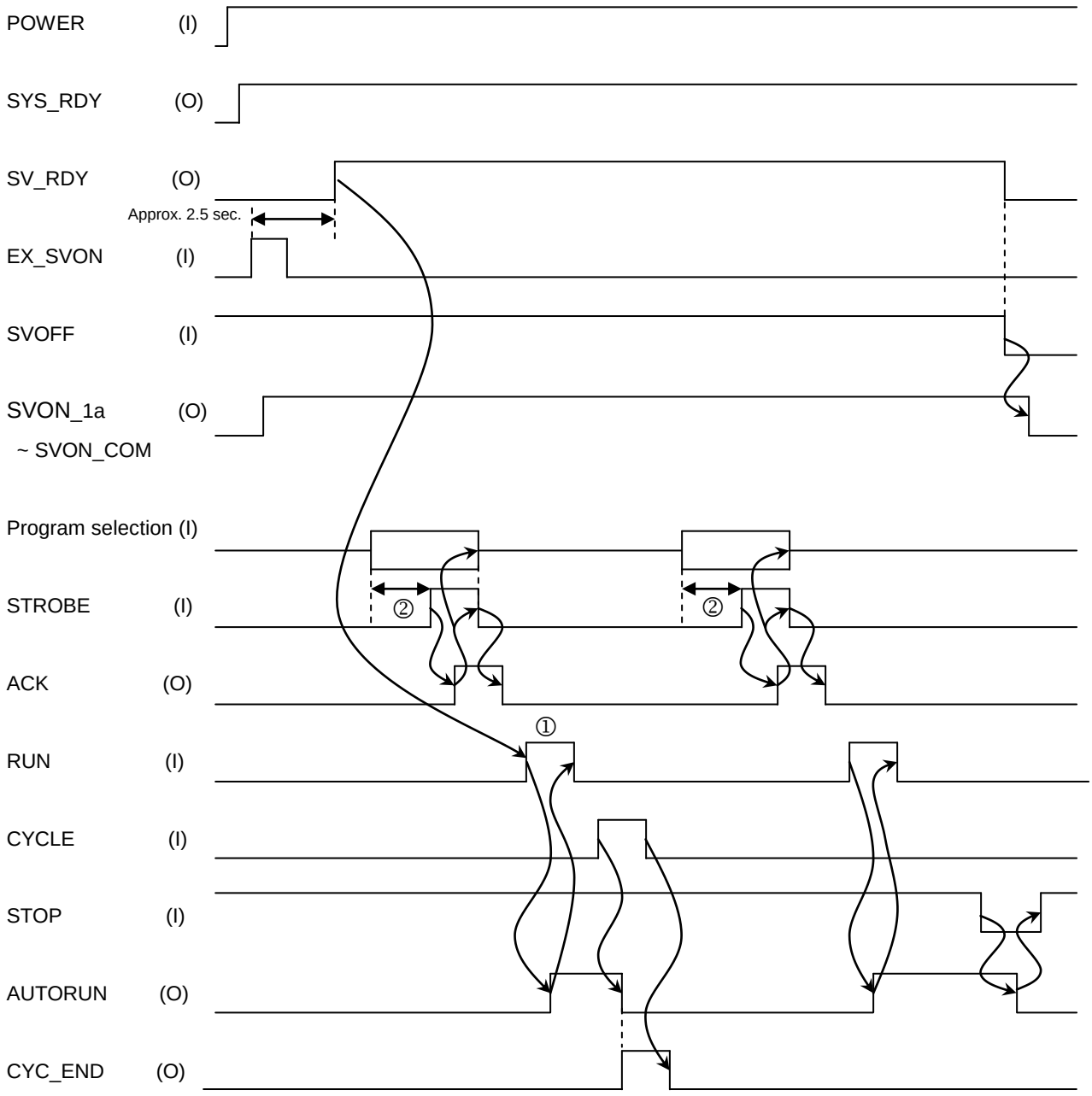
Fig. 4.7 Attaching and detaching external I/O signal cable

To connect an external I/O signal cable, completely insert the cable side connector into the controller side connector and tighten the lock screws on both sides of the connector with a screwdriver.
To disconnect the cable, loosen the lock screws, then pull out the connector. At this time, DO NOT pull the cable instead of the connector. Otherwise, an excessive force will be exerted on the cable, resulting in damage of the cable.

! **CAUTION**	When attaching or detaching the cable, be sure to hold the connector rather than the cable.

4.12 Example of Controller Operation, Using External Signals

(1) Normal operation sequence



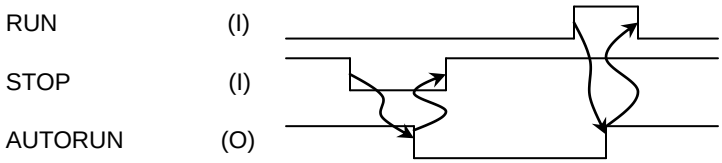
① To include a delay time of 2.5 seconds or over between the EX_SVON signal ON and the RUN signal ON, set ON the RUN signal only after the SV_RDY signal is ON.

② Include a sufficient delay time before the program select signal starts between the program select signal input and STROBE signal input. (200 msec or so)

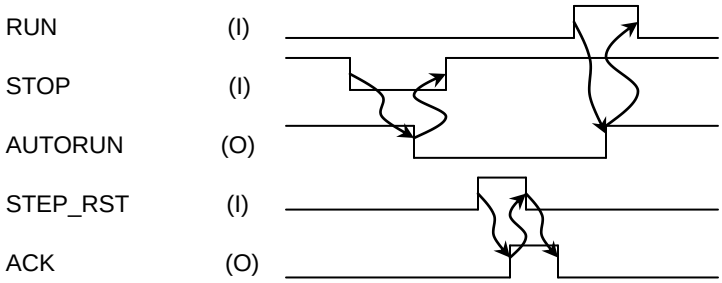
Note: If the SVOFF signal remains (0), the servo cannot be turned on. Before the servo can be turned on, the SVOFF signal must be set to (1).

(2) Example of restarting the stopped robot

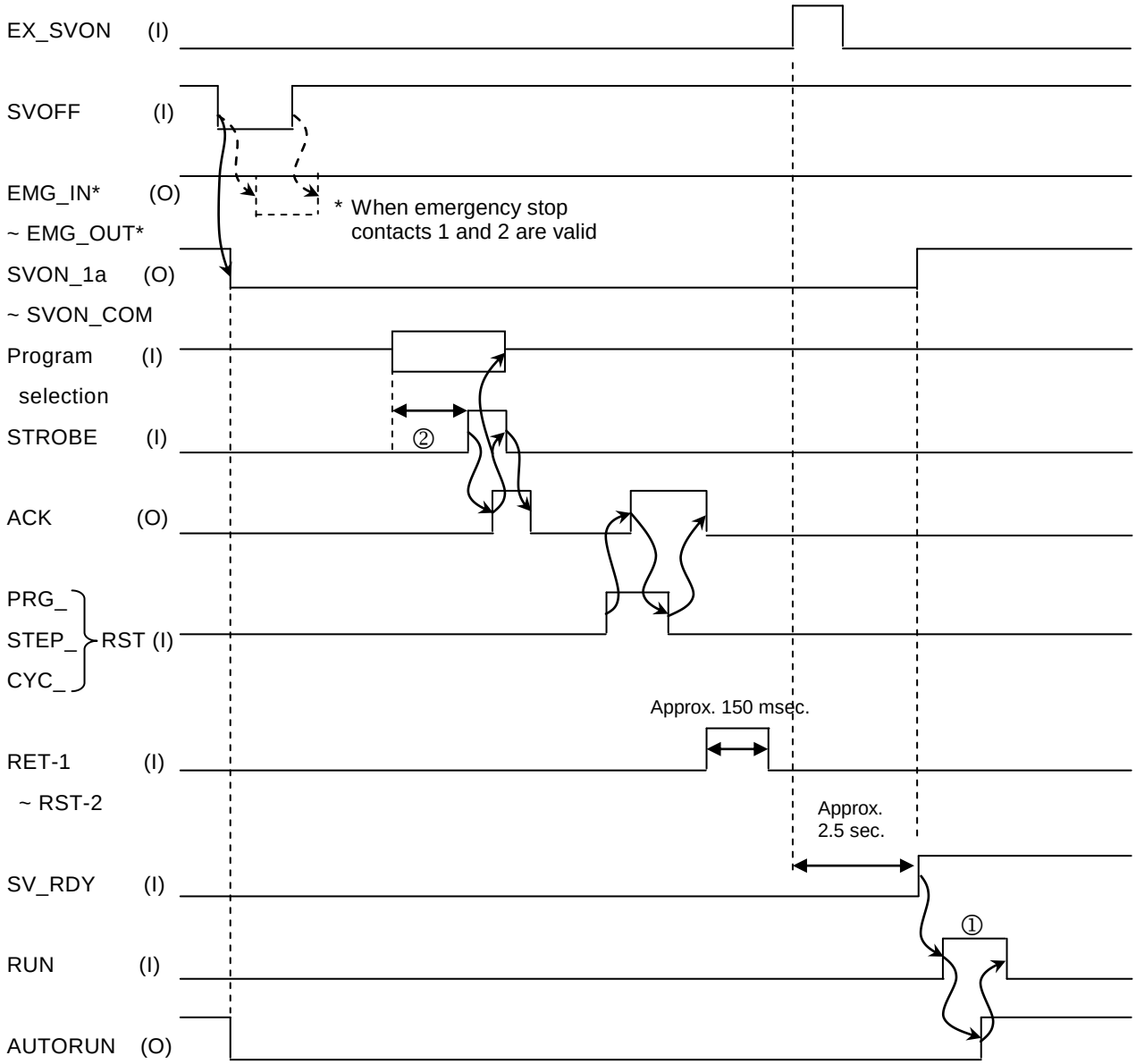
a.) Restart after stop (to resume the operation)



b.) Restart after stop (to start the program from the top)



(3) Example of restarting the robot after servo OFF (emergency stop)



① To include a delay time of 2.5 seconds or over between the EX_SVON signal ON and the RUN signal ON, set ON the RUN signal only after the SV_RDY signal is ON.

② Include a sufficient delay time before the program select signal starts between the program select signal input and STROBE signal input. (200 msec or so)

③ To restore the system while the emergency stop contact input is open, place all connected emergency stop switches in close status. The error can be cleared by short-circuiting the SAFE connector between RST-1 and RST-2 (150 ms (min.).

Note 1: Signals EMG_COM* to EMG_*a and EMG_*b (emergency stop contact output) operate when emergency stop contact inputs 1 and 2 are open and close.

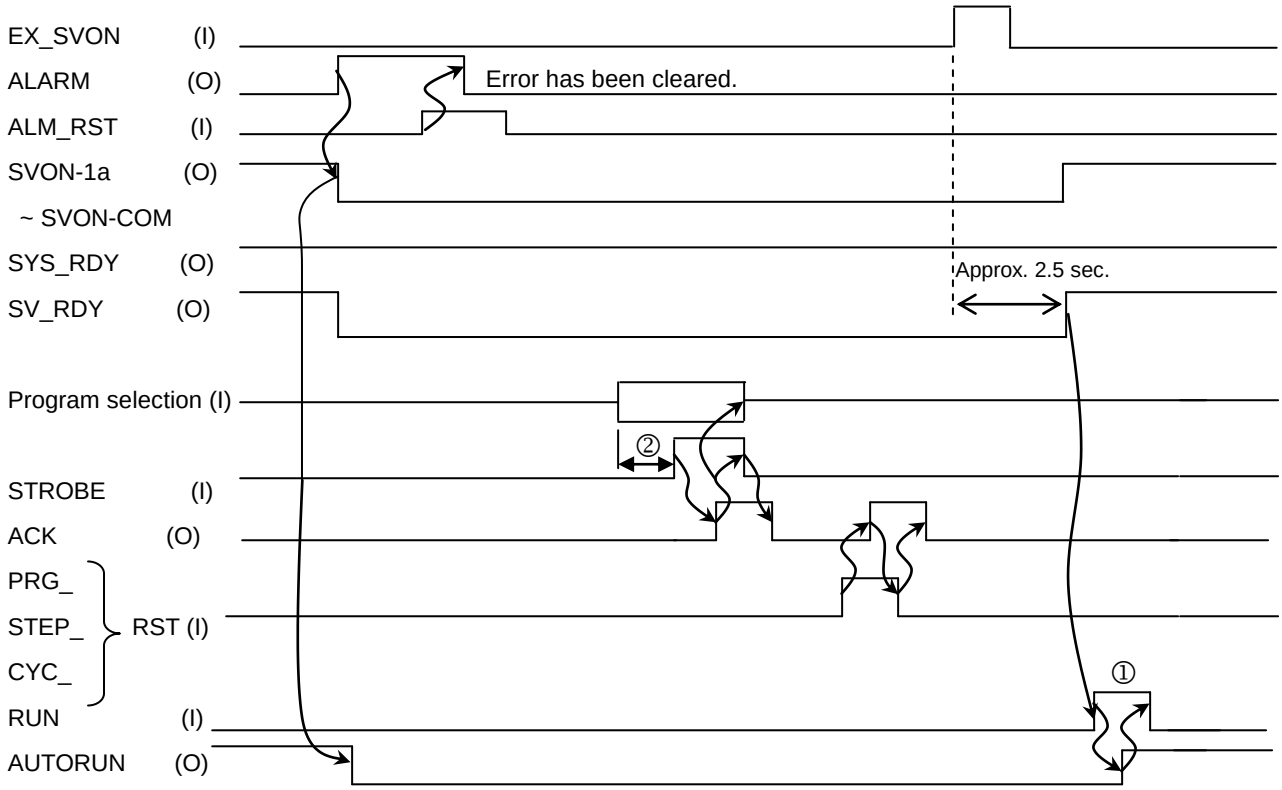
Note 2: Program selection, PRG_RST, STEP_RST and CYC_RST can be skipped unless necessary.

Note 3: Program selection, PRG_RST, STEP_RST and CYC_RST can be executed at any timing unless the auto operation mode is selected.

Note 4: To prevent an internal damage after servo OFF, the interval time is seven (7) seconds when the servo is turned on for the number of times that is a multiple of 3.
If servo is to be turned on again for the first and second times, the EX_SVON signal can be accepted after the SV_RDY signal is turned off. However, be aware that an interval time is included in the third EX_SVON signal.

(4) Example of restarting the robot after error correction

To resume the automatic operation after an error has occurred (i.e., processing of automatic operation after error correction):



① To include a delay time of 2.5 seconds or over between the EX_SVON signal ON and the RUN signal ON, set ON the RUN signal only after the SV_RDY signal is ON.

② Include a sufficient delay time before the program select signal starts between the program select signal input and STROBE signal input. (200 msec or so)

Note 1: To continue the automatic operation, program selection, PRG_RST, STEP_RST and CYC_RST are necessary.

Note 2: The servo power may not be turned off with some type of error.

Note 3: Program selection, PRG_RST, STEP_RST and CYC_RST can be executed at any timing unless the auto operation mode is selected.

4.13 Definition of Colors for Operation Buttons and Indicator Lamps

If the switches or the likes to operate the TSL3000E/TSL3100E robot controller are to be placed out of the controller by the customer, it is requested that the colors of operation buttons be defined as follows:

- Operation buttons

Red - Emergency

Yellow - Trouble

Green - Normal

Blue - Required action (e.g., reset)

- Indication of operation buttons

Start	Stop	Pushbutton which alternately starts and stops	Button which allows operation only when held down, and stops it when released
			

- It is requested that the colors of indicator lamps be defined as follows:

Red - Emergency

Yellow - Trouble

Green - Normal

Blue - Required action (e.g., reset)

Section 5 Serial I/O Signal Cable

5.1 Connecting Serial I/O Signal Cables

The TSL3000E/TSL3100E robot controller is provided with two (2) channels of RS-232C serial I/O signals COM1 and 2. For the connection, see the figure below. It is recommended to use commercially available cables.

Using a surge protector is also recommended in order to protect serial I/O signals from an electrostatic discharge-induced surge or switching surge.

Recommended surge protector: RSP-232-9 manufactured by Okaya Electric Industries Co., Ltd.

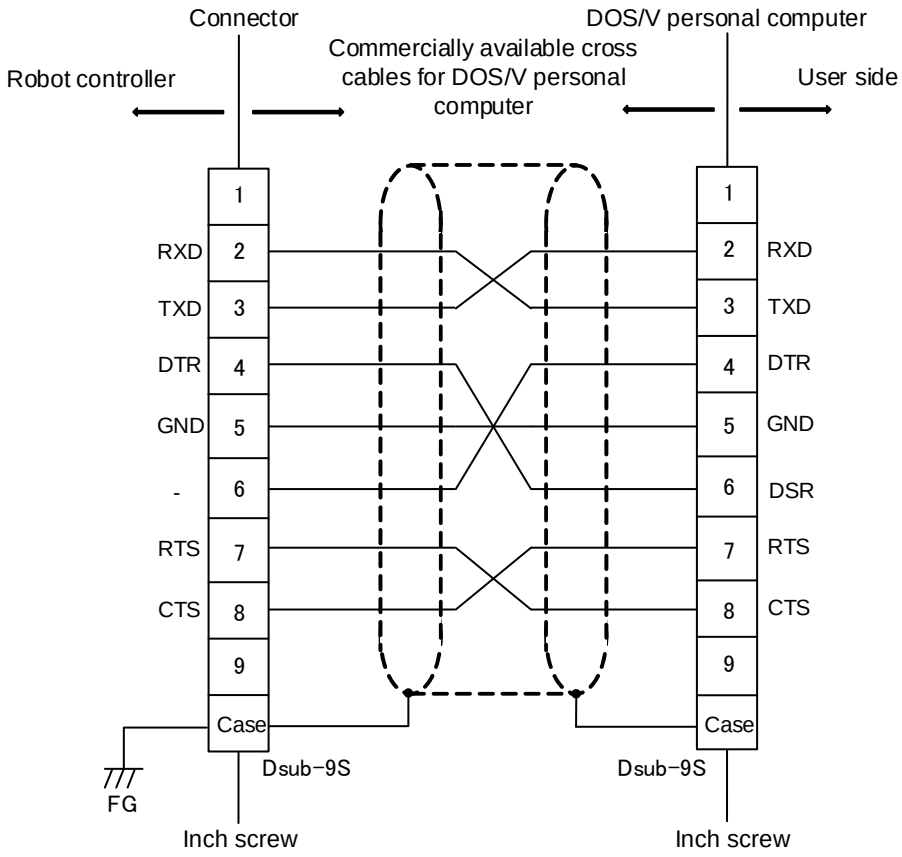


Fig. 5.1 Connection of serial I/O signals HOST/TCPRG and COM1

5.2 Attaching and Detaching Serial I/O Signal Cables

Before attaching or detaching the serial I/O cables to or from the TSL3000E/TSL3100E robot controller, be sure to turn off the main power in the user's control panel.

The procedures for attaching and detaching serial I/O signal cables HOST/TCPRG and COM1 are the same as in Para. 4.11. For details, see Para. 4.11.

! CAUTION

Be sure to turn off the main power before attaching or detaching the cables.

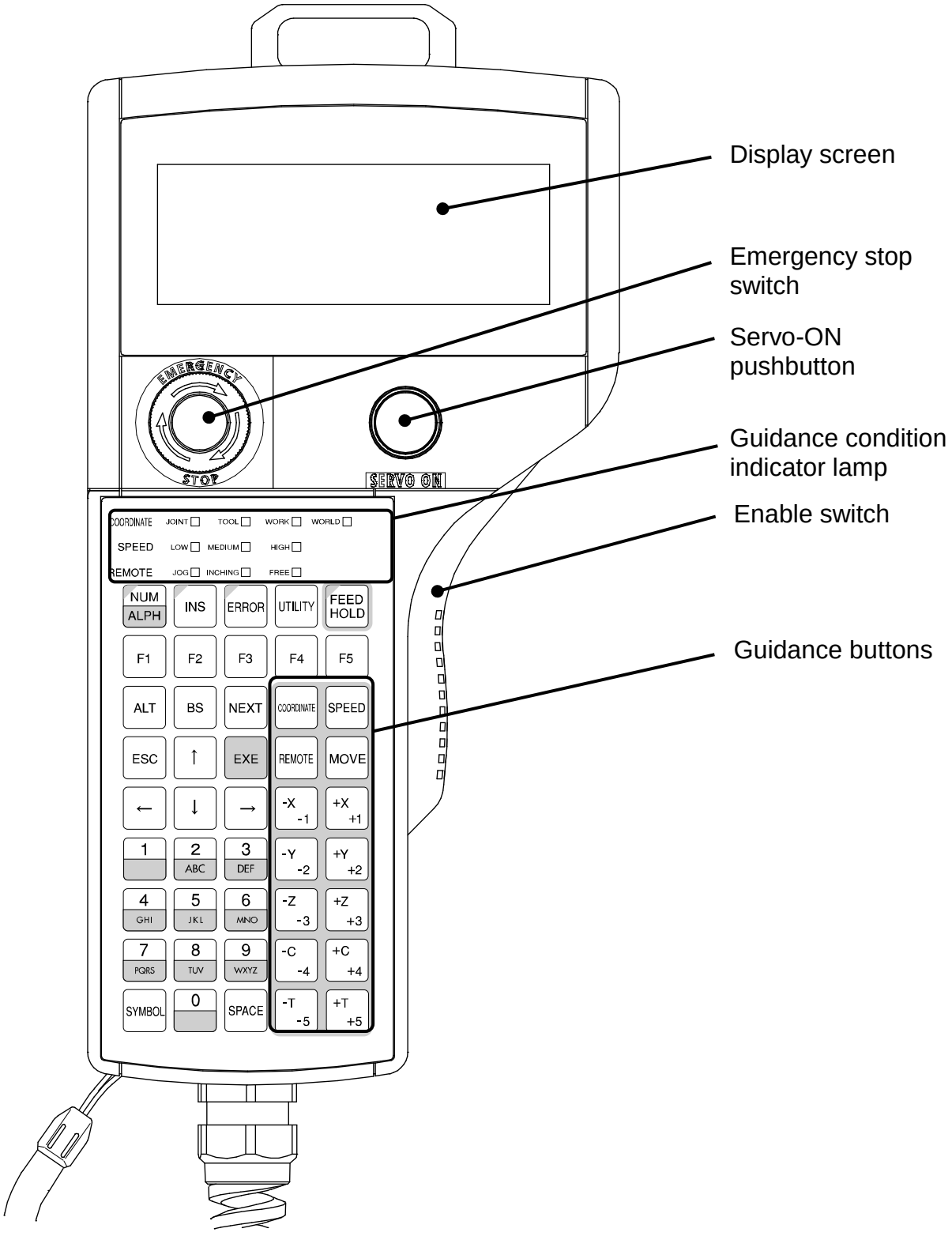
Attaching or detaching the cables with the main power turned on may cause damage on the substrate ICs.

! CAUTION

The connectors below in the TSL3000E/TSL3100E robot controller have connector caps.
HOST/TCPRG, COM1, MEM, OUTPUT
When these connectors are not used, be sure to always attach the connector caps for protecting from electrostatic discharge and damage.

Section 6 Teach Pendant Cable

6.1 External View and Functional Names of the TP1000



6.2 Connecting Teach Pendant (TP) Cable

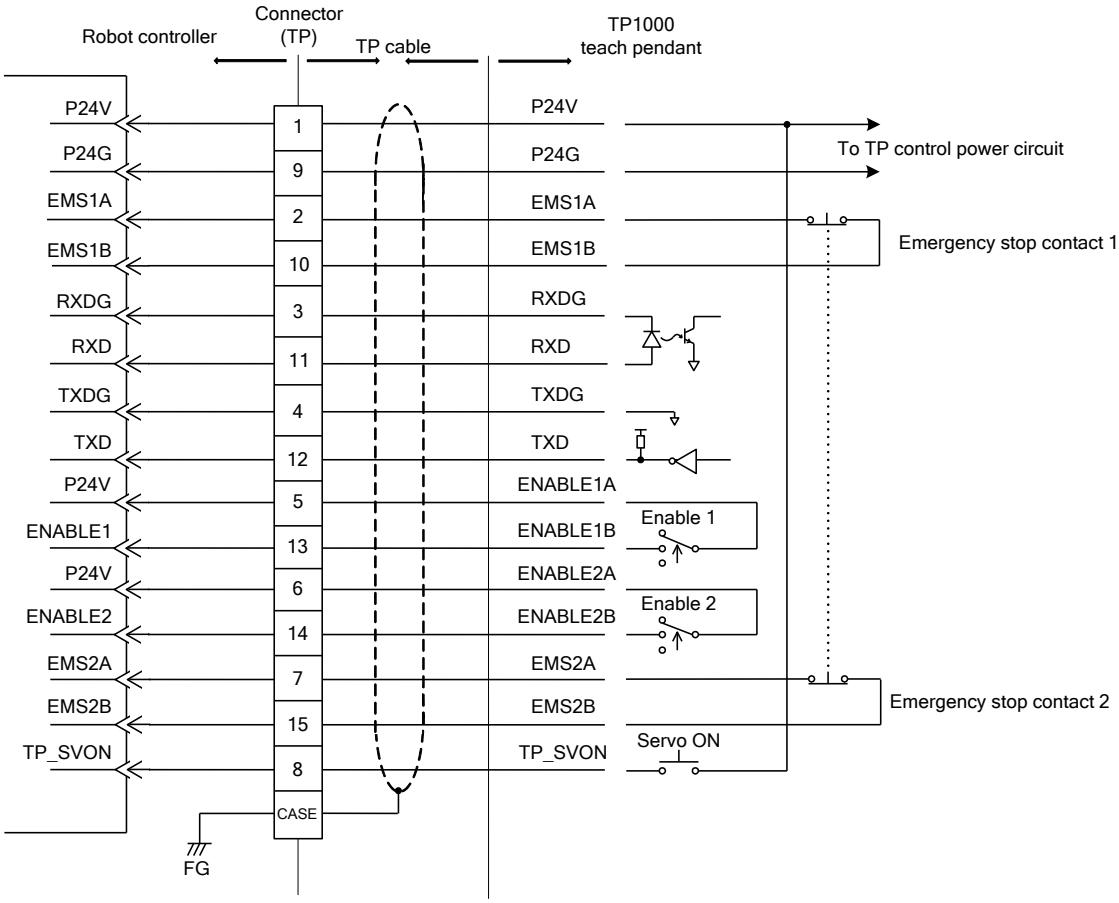


Fig. 6.1 Connection of TP1000 teach pendant I/O signals

The TP cable is a serial I/O signal cable used only for the TP1000 teach pendant (option). One side of the TP cable is secured to the teach pendant and the other side has a D-sub 15-pin connector.

Unless the teach pendant is connected, insert the attached dummy plug to connector TP on the front panel of the controller.

When connecting the teach pendant, remove this dummy plug first. (The attaching and detaching procedures are the same as in Para. 4.11. For details, see Para. 4.11.)

The dummy plug can be removed while the power of the controller is set ON or OFF. If the dummy plug is removed while the servo power is turned on, however, the servo power is turned off automatically. (While the dummy plug or teach pendant is not connected, safety measures are effected to prevent the servo power from actuating.)

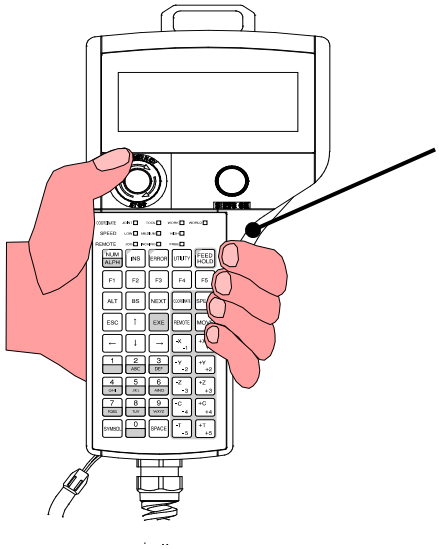
! **CAUTION**	Unless the teach pendant or dummy plug is connected with the TP connector of the TSL3000E/TSL3100E robot controller, the servo power cannot be turned on.

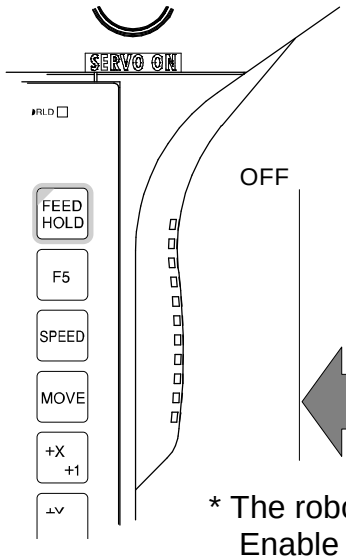
As shown in Fig. 6.1, the teach pendant I/O signals include the I/O signals for data transmission between the teach pendant and controller, signals for identifying servo ON, emergency stop and enable input from the teach pedant, and P24V and P24G signals for supplying the power to the teach pendant.

Data transmission between the teach pendant and TSL3000E/TSL3100E robot controller is performed in the current loop system.
These I/O signals are used exclusively for the TP1000 teach pendant, and cannot be used for any other equipment.
While the teach pendant is disconnected, processing of emergency stop is effective and the servo power cannot be turned on. Unless the teach pendant is used, use the attached jumper connector (D-sub 15 pin).

6.3 How to Operate the Enable Switch

The TP1000 (Teach Pendant) is equipped with a 3-position Enable switch. Use the Enable switch to turn on the servo in teach mode or guide the robot in teach mode.





OFF ON OFF

To turn on the Enable switch, gently hold the switch.

To turn off the Enable switch, grip on the switch. (The robot stops.)

* The robot cannot be guided manually when the Enable switch is OFF.
Keep the Enable switch ON when guiding the robot manually.

Section 7 External I/O Cable (Option)

7.1 Connecting External I/O Cable

The external I/O cable is used to connect the TR48DIOCN/TR48DIOC module (option) or Toshiba Machine's designated remote I/O module (option) serving as the slave station.
Power (24 V, 0 V) is supplied to TR48DIOCN/TR48DIOC by an external power supply provided by the customer.
Select the optimum external power supply based on the system specifications (power capacity) of the customer.
The 5 and 4 pins (24 VDC) of this connector are shared with the external power input connectors for controller INPUT and OUTPUT, hand INPUT and hand OUTPUT. Be sure to supply external 24 VDC to EXT I/O 5 and 4 pins.
Turn on the power to the robot while the power to TR48DIOCN/TR48DIOC module is on. An error occurs depending on the power-on timing.

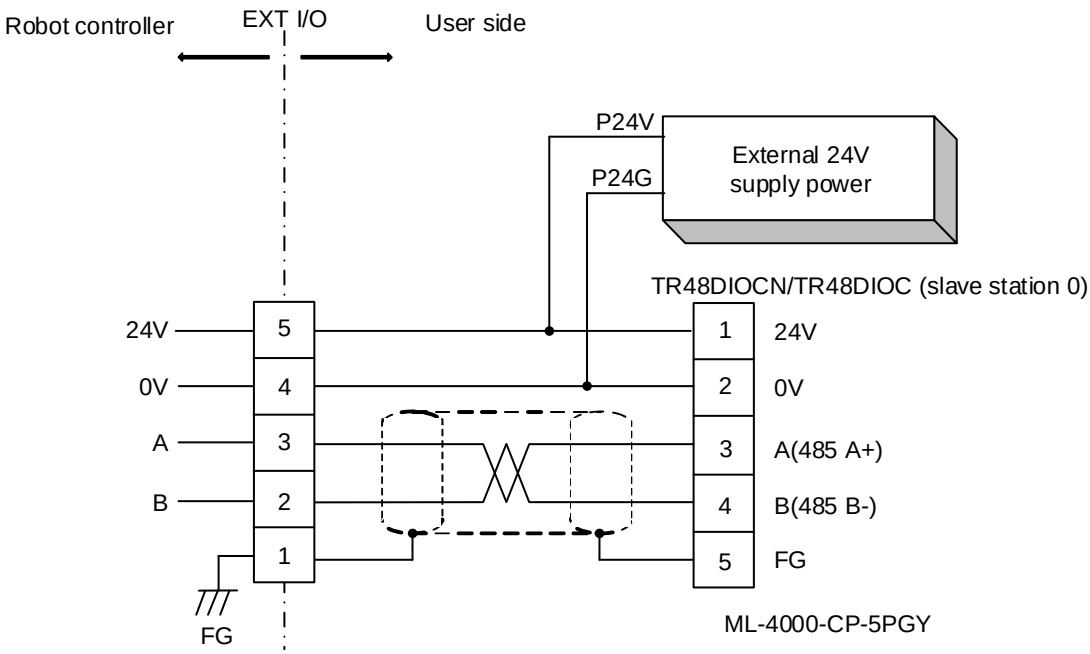


Fig. 7.1 Connection of RS-485 cable

a.) Use the cable attached to the TR48DIOCN/TR48DIOC module, or the cable which satisfies the following specifications.

- Core wires : 0.3 mm^2 to 0.75 mm^2 twisted wires
- Twisted pair : Required.
- Cable outer diameter : Max. 7 mm
- Shield : Batch braided shield
- Cable length : 400 m or less in total
  When the external power is supplied and only the RS485 communication cable is extended.
- Characteristic impedance : 100 Ω
- Others : For RS-485 250 kbps data communication.

Recommended twisted pair cable with shield
TKVVBS 0.3 sq. × 2 P (made by Tachii Densen)

NEVER use a cable which does not conform to the specifications. Otherwise, short-circuit or cable melting due to overheated cable core may be caused. Additionally, the robot may work improperly due to noise.

b.) When connecting two (2) TR48DIOCN/TR48DIOC modules for I/O extension, be sure to branch from the terminal block of slave station 0, as shown in Fig. 7.2. (For the I/O extension, up to two (2) TR48DIOCN/TR48DIOC modules can be connected.)

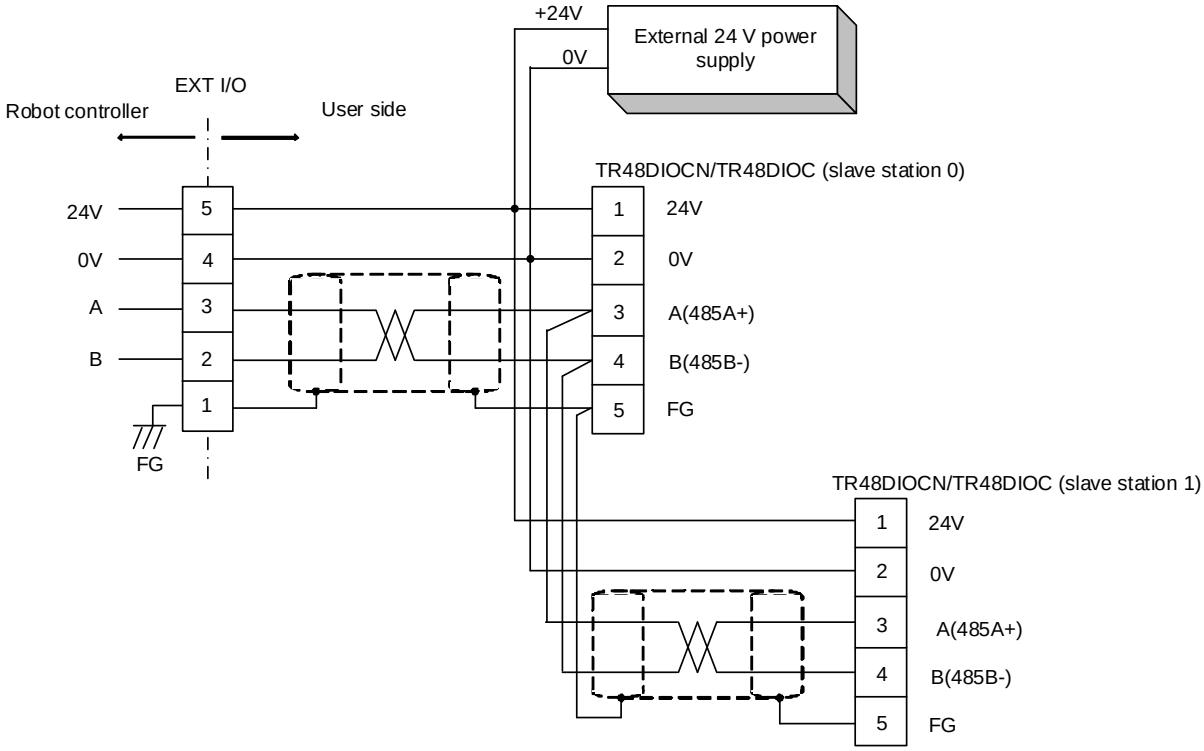


Fig. 7.2 Connection of external I/O cable when external power supply is used

7.2 External I/O Communication

If the number of digital I/Os is insufficient for the system, up to two (2) TR48DIOCN/TR48DIOC modules [option; twenty-eight (28) inputs and twenty (20) outputs] can be connected as the I/O function extension unit. When the TSL3000E/TSL3100E robot controller is assigned to the master station and the TR48DIOCN/TR48DIOC module to the slave station, inputs and outputs can be controlled via the RS485 serial communication.
In addition to the TR48DIOCN/TR48DIOC module, a distribution I/O module designated by Toshiba Machine, which can serve as the slave station, can be used also.

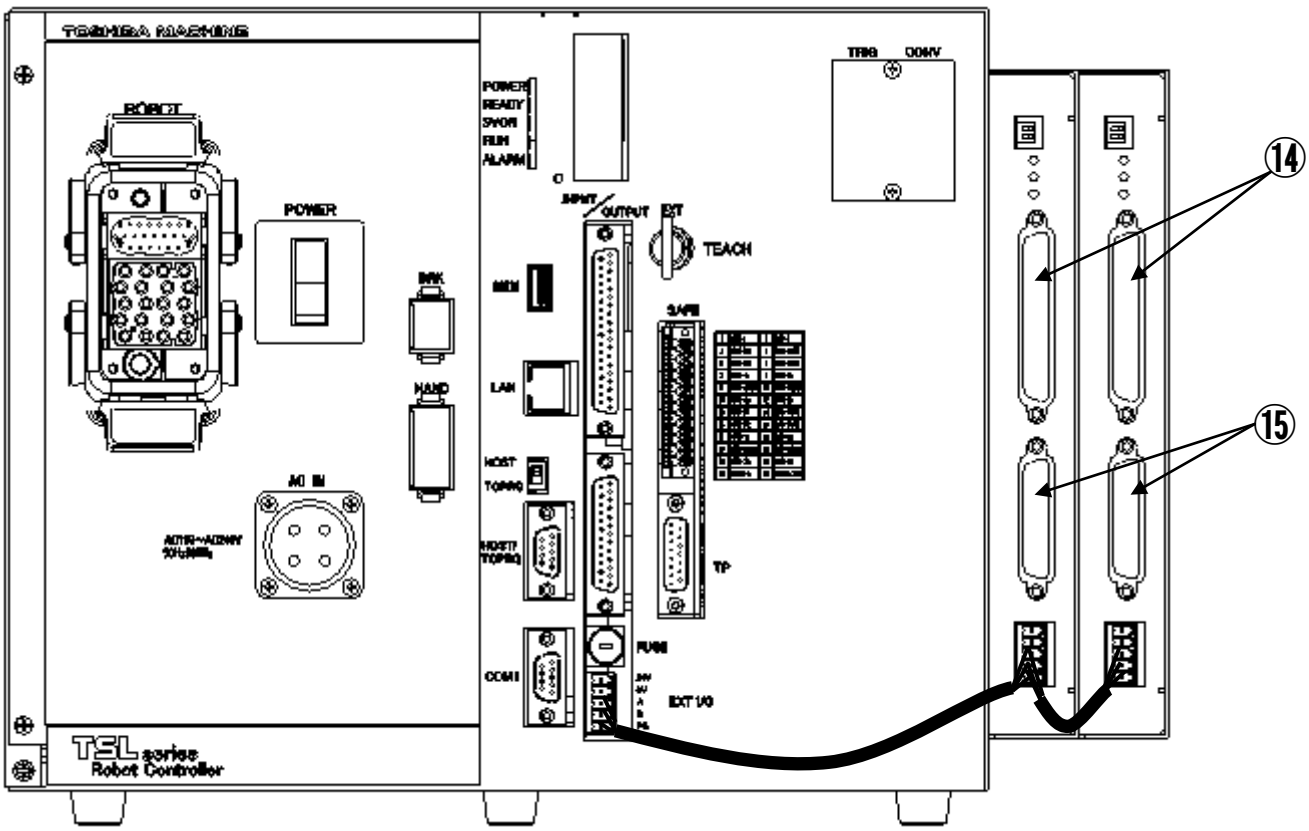


Fig. 7.3 TSL3000E/TSL3100E + TR48DIOC (2 units)

* To designate the slave station number of the TSL3000E/TSL3100E, observe the following steps. Under [U12] of the USER.PAR (user parameter) file, you can find the following parameter setting related to the extension input and output.

  [U12] Extend I/O setting
  {Use/Not Use} (0: Not Use, 1: Use)
  {Not Use}
  {Not Use}
  = 0 28 20 → Corresponds to station 0.
  = 0 28 20 → Corresponds to station 1.

  If you wish to use only station 0 (i.e., one (1) TR48DIOC module), for instance, change the underlined bit corresponding to station 0 to "1".
  = 1 28 20
  = 0 28 20

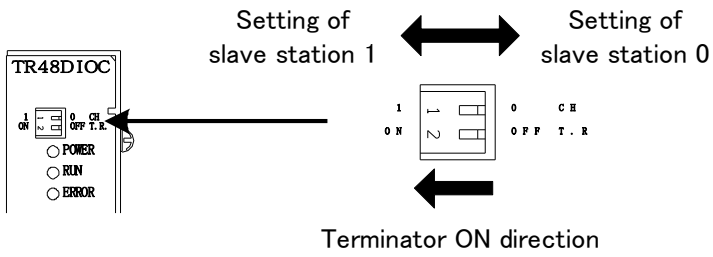
  After saving the parameter file, turn off the controller power and on again. Then the above parameter becomes effective.

  If you wish to use both stations 0 and 1 (i.e., two (2) TR48DIOC modules), specify as follows and perform the same operation as above to make the parameter valid.
  = 1 28 20
  = 1 28 20

When using the TR48DIOC module, careful precautions should be taken on the following matters.

[1] Make sure that the slave station number set in "USER.PAR" (User parameter) coincides with the station number setting of the TR48DIOC module.

[2] When the TR48DIOC module or modules are connected, set ON the terminator setting switch equipped on the TR48DIOC module which is located on the extreme right side in terms of cable wiring when seen from the controller front side.
The switches (2 pins) provided on the front upper side of the TR48DIOC module represent pin 1 (upper) for slave station number setting and pin 2 (lower) for terminator setting.



The slave station setting is already described above. Specify the slave station of TR48DIOC to be used, according to the station number set in "USER. PAR" (User parameter).

For the terminator, when only one (1) TR48DIOC module is used, set ON the terminator setting switch equipped on the module.
When two (2) TR48DIOC modules are used, see Fig. 7.3 for example. As the TR48DIOC module on the extreme right side as viewed from the controller front side is the terminal station in terms of cable wiring, set ON the terminator setting switch equipped on this module alone. The terminator of the left TR48DIOC module should remain OFF.

Be sure to execute Items [1] and [2] above. Otherwise, the system does not function normally and go wrong.

With the above setting, make sure that both the POWER and RUN LEDs on each TR48DIOC module are illuminated.

Turn on the power to the robot while the power to TR48DIOCN/TR48DIOC module is on. An error occurs depending on the power-on timing.

7.3 Attaching and Detaching External I/O Cable

For the external I/O cable, use the cable attached to the TR48DIOCN/TR48DIOC module, or a cable which meets the specifications.
Before attaching or detaching the external I/O cable to or from the TSL3000E/TSL3100E robot controller, be sure to turn off the main power.

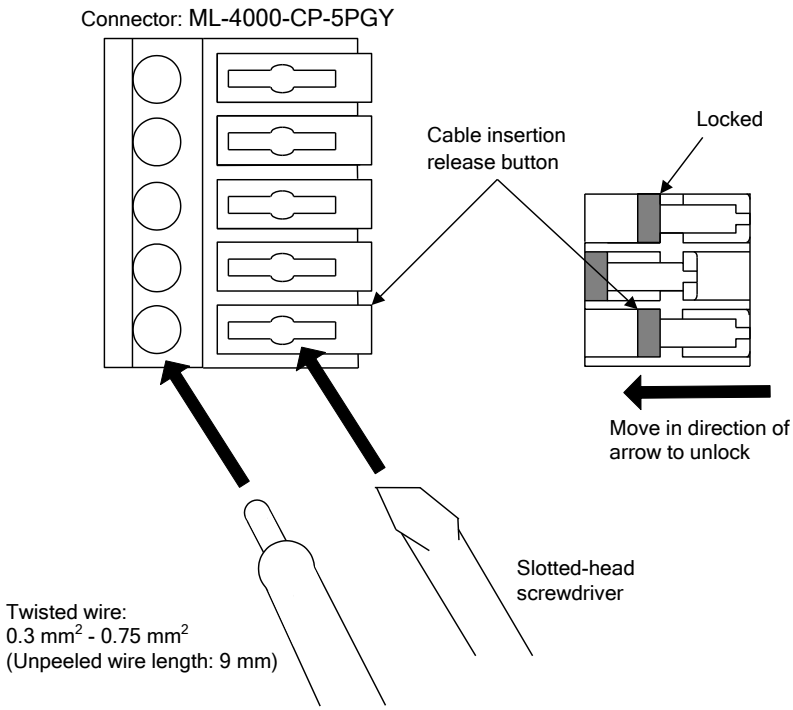


Fig. 7.4 Attaching and detaching external I/O cable

To connect the external I/O cable, press a slotted-head screwdriver onto the cable insertion release button of the connector as shown in Fig. 7.4 to lock the cable insertion release button so that the cable can be inserted or removed. After the cable is firmly pressed in, raise the cable insertion release button upwards to release the lock.
(Lightly pull the cable and make sure that the cable is connected completely and will not come off. DO NOT pull the cable by force, however. Otherwise, an unusually large force is exerted on the cable, resulting in loose cable connection.)
To remove the cable, press the slotted-head screwdriver onto the cable insertion release button so that the cable insertion release button is locked, and then pull out the cable.

Section 8 Extension I/O Signal Cable

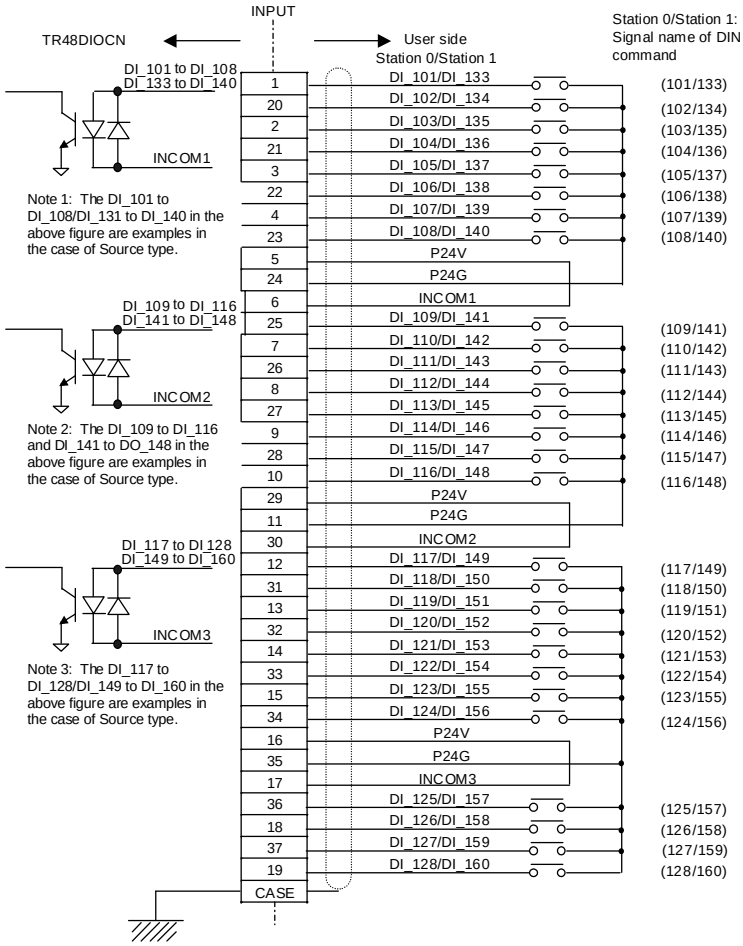
The TR48DIOCN/TR48DIOC is an extension I/O module having 28 inputs and 20 outputs. The TSL3000E/TSL3100E can be expanded up to a maximum of two stations. The output specifications are different between the TR48DIOCN and TR48DIOC (Source type/Sink type). Check which type of extension I/O module you are using before connecting the extension I/O signal cable.

8.1 TR48DIOCN

The TR48DIOCN output specifications are Sink type.
Because the input specifications use bidirectional photocouplers in the input circuit, the selection of INCOM* enables switching between Source type and Sink type.

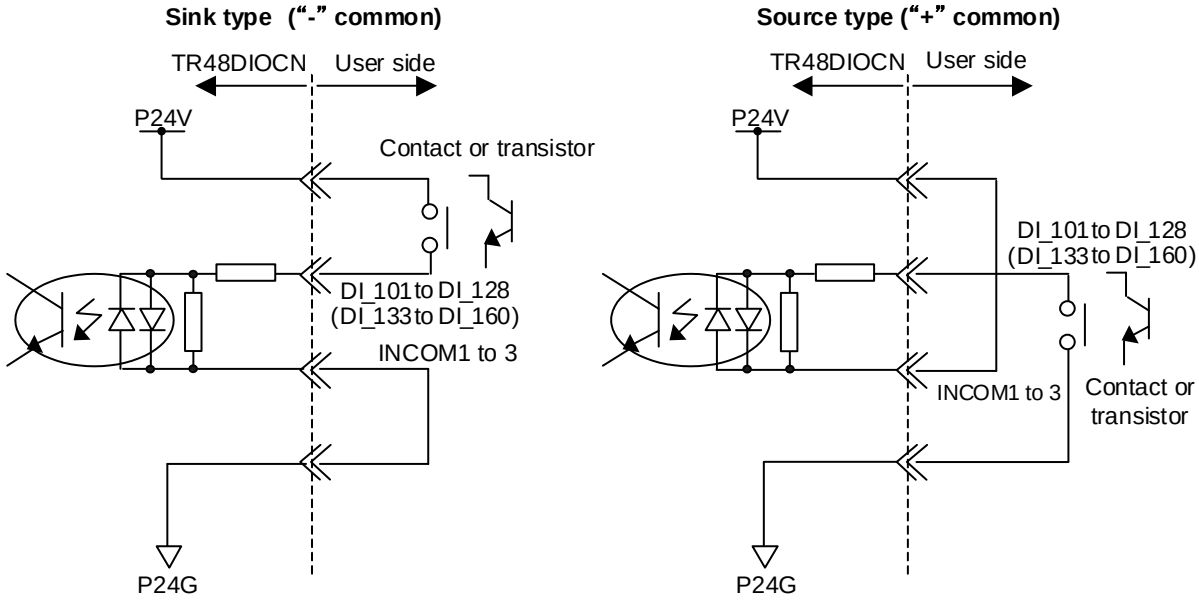
8.1.1 Connecting Extension Input Signal Cable

The connection of the extension input signal cable uses the connector XM3A-3721 (plug type) and XM2S-3711 (connector cover) supplied with the TR48DIOCN. The TR48DIOCN inputs (DI_101 to DI_128 (Station 0) and DI_133 to DI_160 (Station 1), are connected to the connector INPUT on the module panel.



The specifications of the extension input signals are shown below.

- Input format: No-voltage contact input or transistor open collector input
- Application circuit examples and input circuit configuration

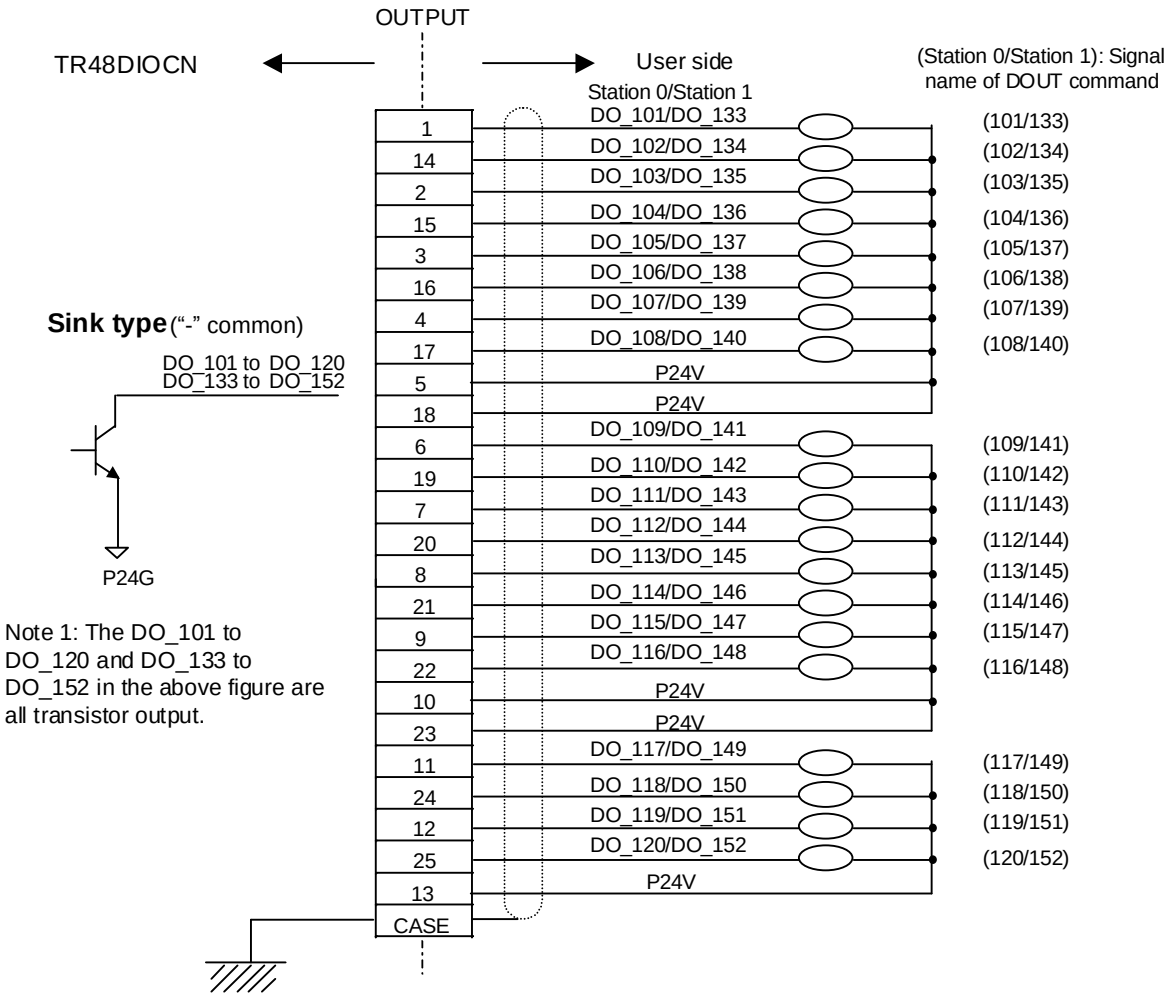


- No-voltage contact/transistor required specifications

No-voltage contact specifications		Transistor specifications	
Contact rating	24V DC 10 mA or more	Collector-emitter voltage	30 V or more
Circuit current	Approx. 7 mA	Collector-emitter current	10 mA
Minimum current	24V DC 1 mA	Circuit current	Approx. 7 mA
Connection impedance	100 Ω or less	Collector-emitter leakage current	100 μA

8.1.2 Connecting the Extension Output Signal Cable

The connection of the extension output signal cable uses the connector XM3A-2521 (plug type) and XM2S-2511 (connector cover) supplied with the TR48DIOCN. The TR48DIOCN outputs (DO_101 to DO_120 (Station 0) and DO_133 to DO_152 (Station 1), are connected to the connector OUTPUT on the module panel.



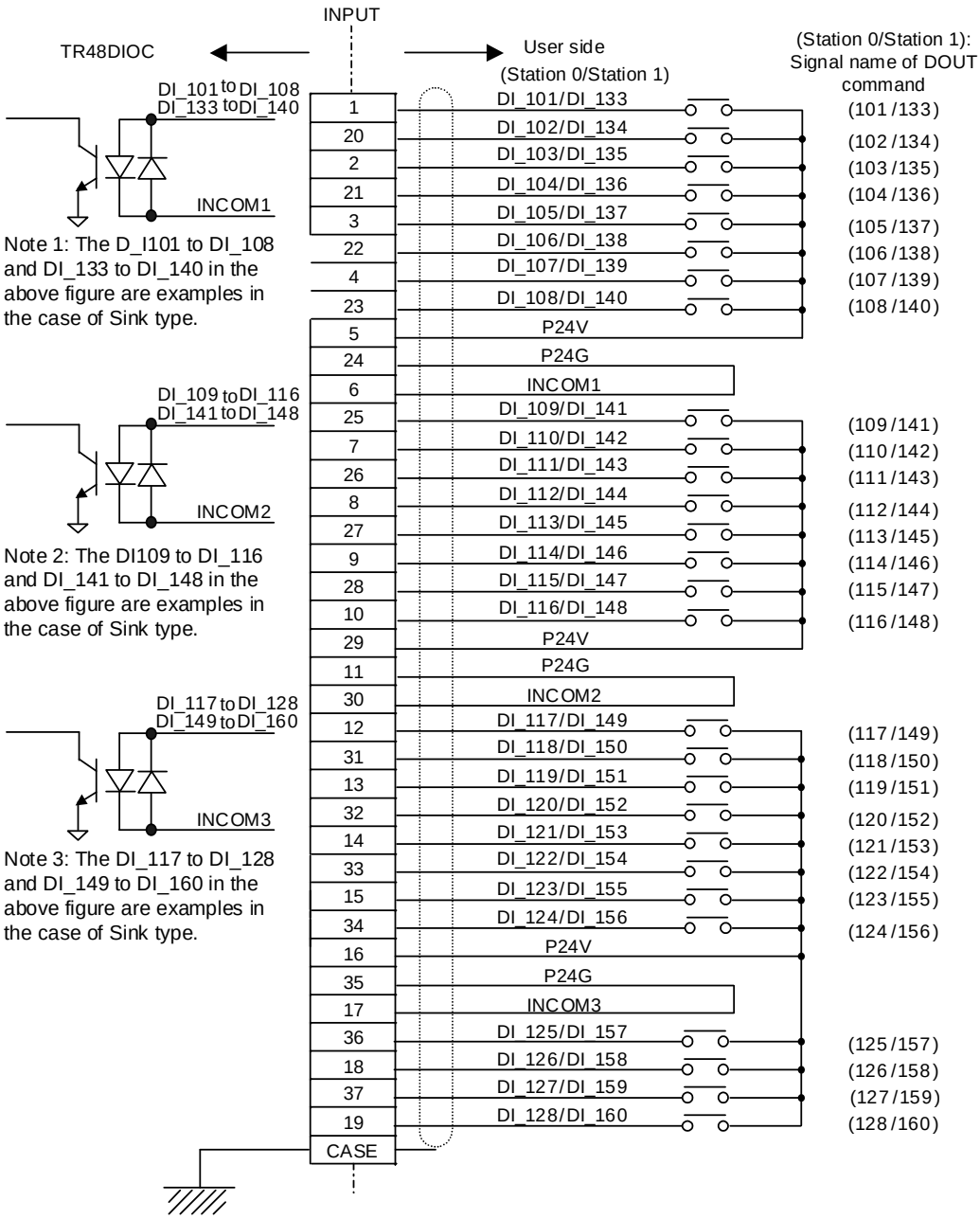
Because the extension output signal specifications are identical to the digital output signal specifications (Sink type) in Para. 4.9.2, refer to this for further information.

8.2 TR48DIOC

The TR48DIOC output specifications are Source type.
Because the input specifications use bidirectional photocouplers in the input circuit, the selection of INCOM* enables switching between Source type and Sink type.

8.2.1 Connecting the Extension Input Signal Cable

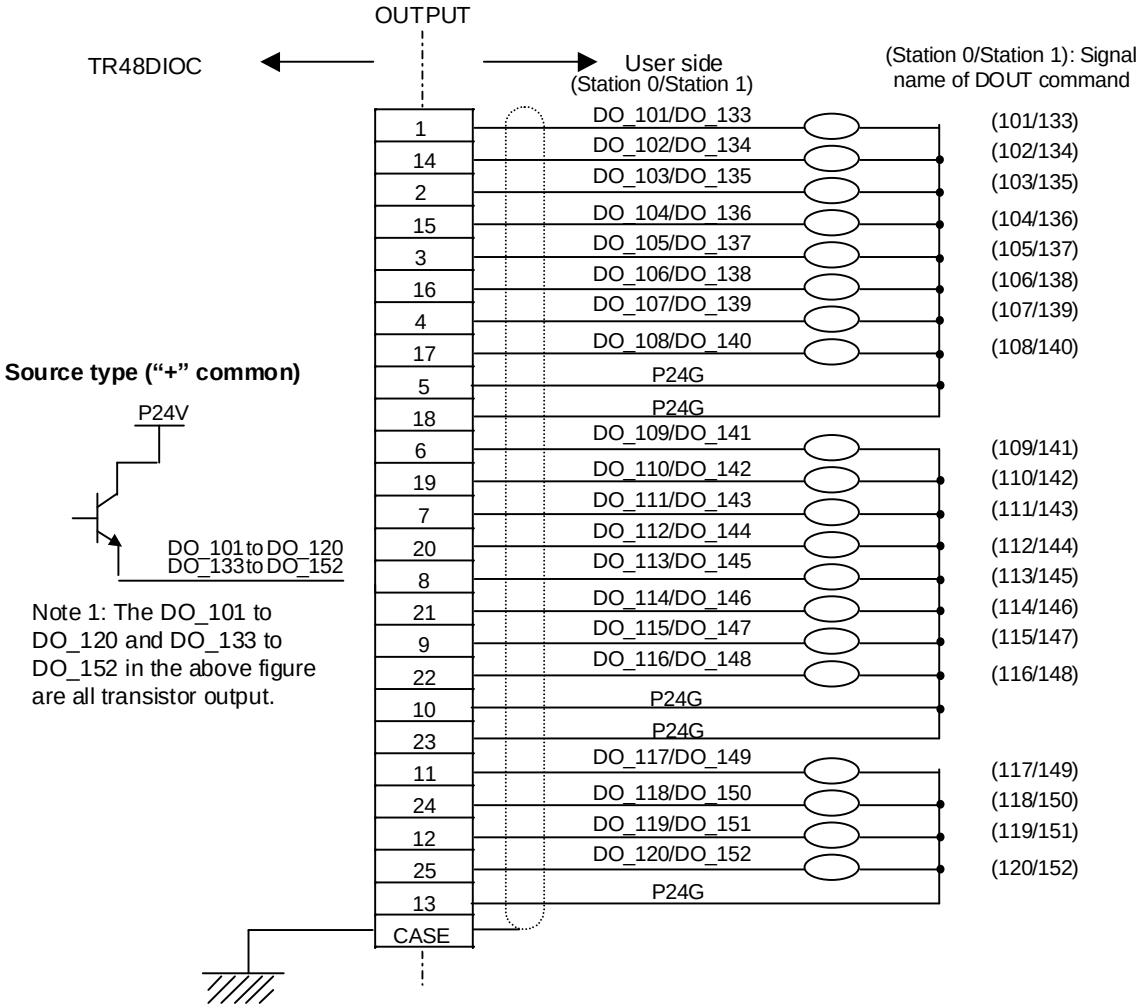
The connection of the extension input signal cable uses the connector XM3A-3721 (plug type) and XM2S-3711 (connector cover) supplied with the TR48DIOC. The TR48DIOC inputs (DI_101 to DI_128 (Station 0) and DI_133 to DI_160 (Station 1), are connected to the connector INPUT on the module panel.



The specifications of the TR48DIOC extension input signals are identical to those for TR48DIOCN, and so see Para. 8.1.1 for the input specifications.

8.2.2 Connecting Extension Output Signal Cable

The connection of the extension output signal cable uses the connector XM3A-2521 (plug type) and XM2S-2511 (connector cover) supplied with the TR48DIOC. The TR48DIOC outputs (DO_101 to DO_120 (Station 0) and DO_133 to DO_152 (Station 1), are connected to the connector OUTPUT on the module panel.



Because the extension output signal specifications are identical to the digital output signal specifications (Source type) in Para. 4.9.2, refer to this for further information.

Electrical rating

Electrical rating		Notes
Rated voltage	24 V DC	Select the optimum external power supply based on the system specifications (power capacity) of the customer. If a current exceeding the rated output flows, the output elements can be damaged or the board can be burned. Therefore, be sure to always use within the rated current range. Use of an external power supply can result in a breakdown, and so never use an external power supply.
Rated current	100 mA (Max.)	

8.3 Fabricating Extension I/O Signal Cable

Follow the points below when fabricating the extension I/O signal cables.

a. Either use the connectors supplied with the TR48DIOCN/TR48DIOC, or prepare the same type of connectors for use. Equivalent products by other manufacturers (D-sub connectors) can also be used.

Connector name	Connector model	Manufacturer
INPUT	XM3A-3721 (plug-type connector) XM2S-3711 (connector cover)	OMRON
OUTPUT	XM3A-2521 (plug-type connector) XM2S-2511 (connector cover)	

b. Select the cables that are used based on the specifications below.
- Core wires: 0.18 mm^2 to 0.32 mm^2 twisted wire
- Cable outer diameter: Maximum 113 mm diameter (INPUT), 111 mm diameter (OUTPUT)
- Shielding: Uniform shielding
- Cable length: 30 m max.

Use of cables that do not match the specifications can result in a meltdown due to a short-circuit or core wire overheating and also presents a danger of robot malfunction due to the intrusion of noise. Therefore, never use cables outside the specifications range.

c. The INPUT and OUTPUT connectors are solder cup type where the wires are joined by soldering. For further information about the methods of joining wires to a connector and shielding processes, see Appendix 2, "Fabricating Cable Using D-sub Connector".

8.4 Attaching and Detaching Extension I/O Signal Cable

For attaching and detaching the extension I/O signal cable, see Para. 4.11.

Section 9 Connection of Trigger Input Signal Cable (TRIG) (Option)

The TSL3000E/TSL3100E has eight optional trigger input points. A 0.22-ms (calculated value) filter is embedded for usual input, but a mere 2.2-μs (calculated value) filter is embedded for trigger input. To prevent a robot controller malfunction, input non-chattering, low-noise signals.

The input specifications define the use of bidirectional photocouplers in the input circuit, so Source type or Sink type is selectable depending on the selection of COM.

To connect the trigger input signal cable, use the connector [XM3D-1521 (socket-type connector), XM2S-1511 (connector cover)] supplied with the robot controller.

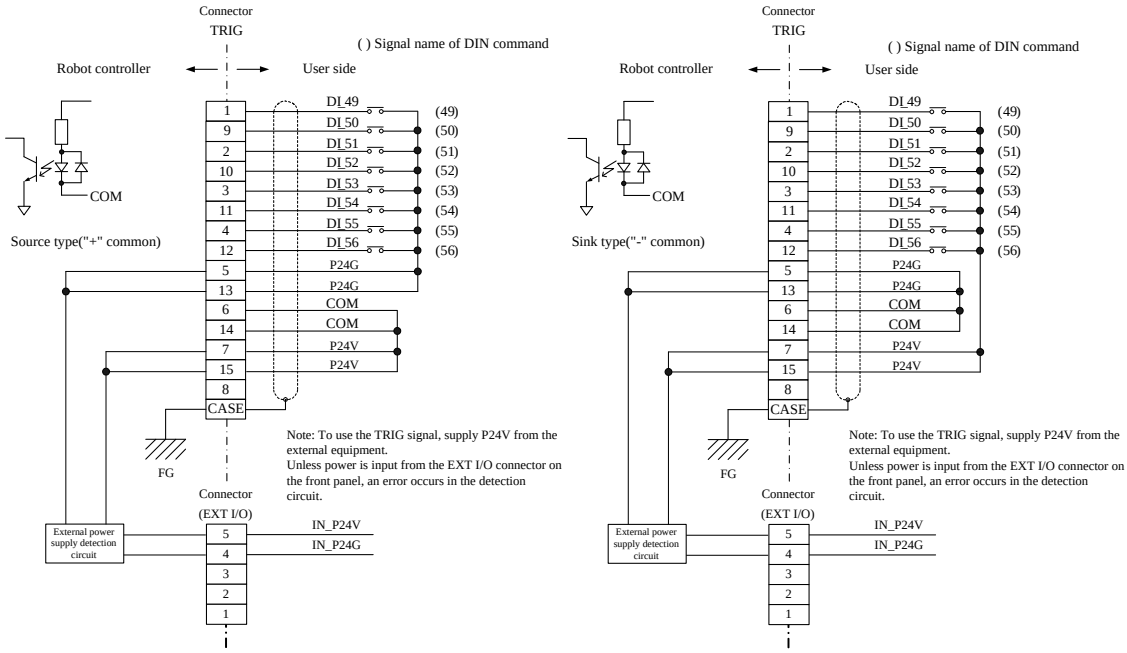


Fig. 9.1 Connection of trigger input signal cable

The trigger input signal specifications are the same as those for the TR48DIOCN/TR48DIOC, so see Para. 8.1.1 for specification details.

If the above trigger input is used as the conveyor synchronization start trigger input function, it cannot be used as the high-speed input function.

9.1 Fabricating Trigger Input Signal Cable

Follow the points below when fabricating the trigger input signal cable.

a. Use either the connectors supplied with the robot controller TSL3000E/TSL3100E or your-prepared connectors of the same type. Equivalent products (D-sub connectors) of other manufacturers can also be used.

Connector name	Type of connector	Maker
TRIG	XM3D-1521(socket-type connector) XM2S-1511(connector cover)	OMRON

b. Select the cables which meet the following specifications.
- Core wires : 0.18 mm^2 to 0.32 mm^2 twisted wires
- Cable outer diameter : Max. 10 mm
- Shield : Batch braided shield
- Cable length : 30 m or less

NEVER use cables which do not conform to the specifications. Otherwise, a short circuit or cable melting due to overheated cable core may be caused. Additionally, the robot may work improperly due to noise.

c. The TRIG connectors are of a solder cup type which joins cables by soldering. For how to join cables to connectors and how to shield cables, see Appendix 2.

9.2 Attaching and Detaching Trigger Input Signal Cable

For attaching and detaching the trigger input signal cable, see Para. 4.11.

Section 10 Connection of Conveyor Synchronization Signal Cable (CONV) (Option)

The TSL3000E/TSL3100E has optional encoder input points for two-channel conveyor synchronization.
Use encoders provided with A- and B-phase signals having 90° phase and the output circuit having RS-422 differential output (line driver). To connect the encoder signal cables, use the connectors [PCR-E20FS+ (connector), PCR-V20LB (hood)] supplied with the robot controller.
It is requested that shielded twisted-pair cables be used as the conveyor synchronization signal cables and that they be connected in pairs as shown below. Note that a wrong connection method degrades the noise resistance, causing a robot controller malfunction.
See the instruction manual "CONVEYOR SYNCHRONIZATION FUNCTION" for further information.

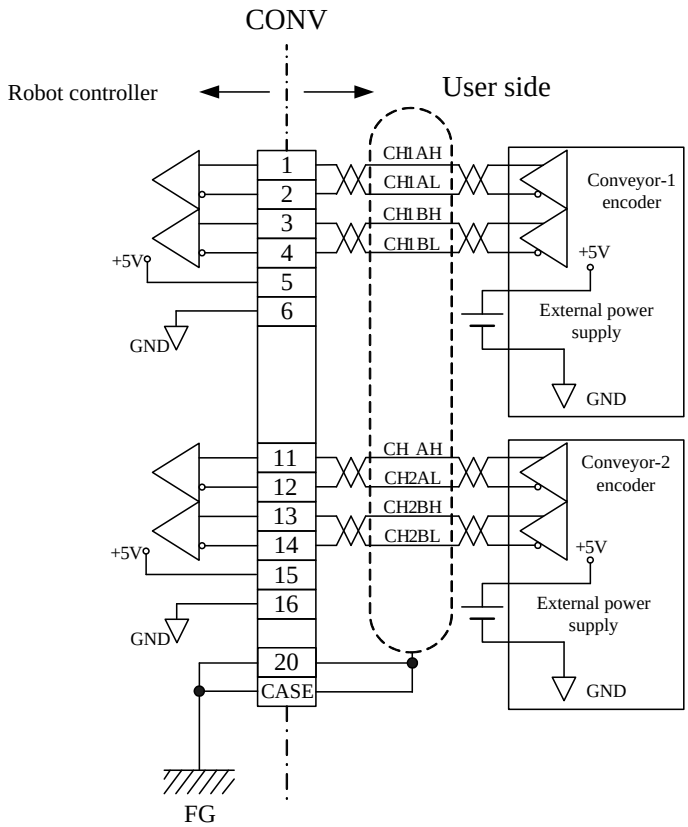


Fig. 10.1 Connection between incremental encoders (with external power supplies used)

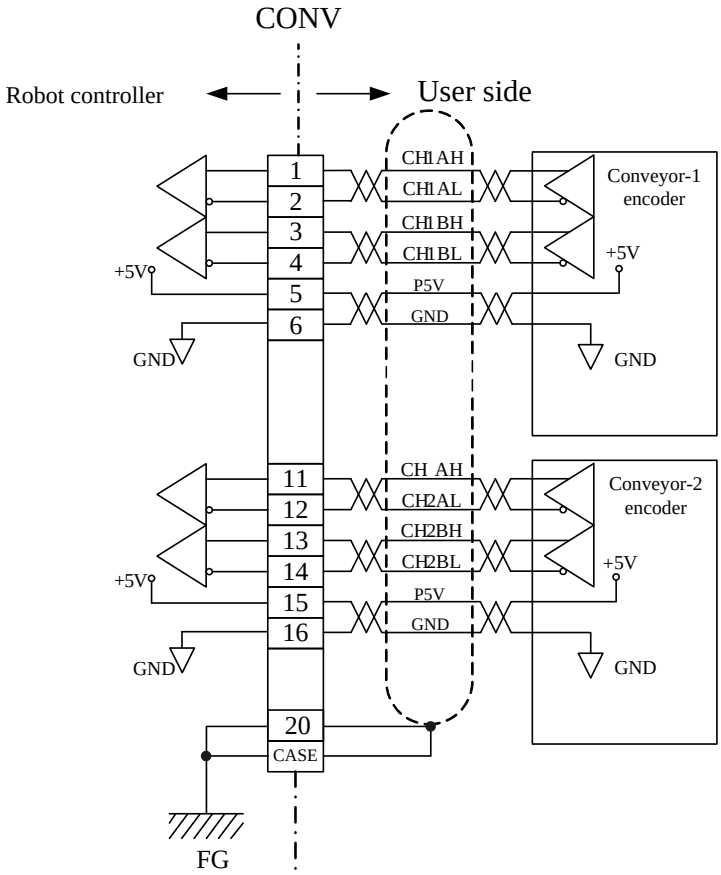


Fig. 10.2 Connection between incremental encoders (with internal power supplies used)

10.1 Fabricating Incremental Encoder Input Signal Cable

Follow the points below when fabricating the incremental encoder input signal cables.

a. Use the connectors supplied with the robot controller.

Connector name	Type of connector	Maker
CONV	PCR-E20FS+(connector) PCR-V20LB(hood)	Honda Tsushin Kogyo Co., Ltd.

b. Select the cables which meet the following specifications.

- Core wires : 0.2 mm^2 to 0.52 mm^2 twisted wires
- Cable outer diameter : Max. 8 mm
- Shield : Batch braided shield

NEVER use cables which do not conform to the specifications. Otherwise, a short circuit or cable melting due to overheated cable core may be caused. Additionally, the robot may work improperly due to noise.

c. The CONV connectors are of a solder cup type which joins cables by soldering. For how to join cables to connectors and how to shield cables, see Appendix 2.

10.2 Attaching and Detaching Incremental Encoder Input Signal Cable

See the following for how to attach and detach the incremental encoder input signal cables.
Be sure to turn off the controller before attaching/detaching the cables.

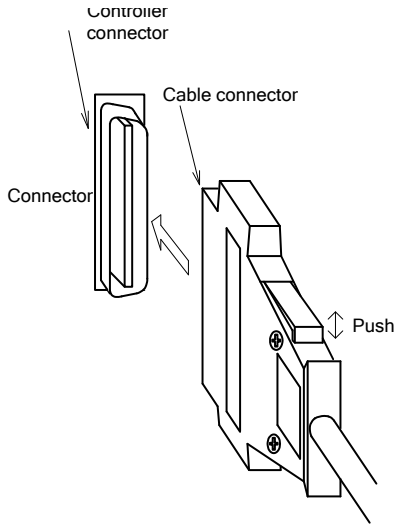


Fig. 10.3 Attaching and detaching incremental encoder input signal cable

To disconnect the cable, unlock and pull out the CONV connector.
At this time, DO NOT pull the cable instead of the connector. Otherwise, an excessive force will be exerted on the cable, causing cable damage.

! CAUTION

When attaching or detaching the cable, be sure to hold the connector rather than the cable.

CAUTION

Be sure to turn off the main power before attaching or detaching the cables.

Attaching or detaching the cables with the main power turned on may cause damage on the substrate ICs.

Section 11 LAN Signal Cable "LAN"

The TSL3000E/TSL3100E has a single LAN port channel as standard.
The LAN communication function enables communication with computers or visual equipment on the Ethernet in the same local area through the TCP/IP.
The function also enables the creation and editing of programs using the computer programmer TSPC, debugging start assistance, and maintenance.
Use a straight cable if a hub is used for connection with external equipment. Use a cross cable if a computer and the controller are connected directly one-to-one. The equipment to be used has an automatic recognition function, which allows the use of both straight and cross cables. For further information, see the equipment specifications.
For details on the LAN communication function, see the "Communication Manual".

Communication specifications

a. Interface : 10BASE-T
b. Communication mode : TCP
c. Baud rate : 10 Mbps
d. Maximum packet size : 512 bits/packet
e. Maximum number of ports simultaneously connected: 4
f. Internal connector (X8GC) : RJ-45 (shielded)
g. Usage : IP0 → Simple procedural communication (host computer)
IP1/IP2 → Non-procedural communication (external equipment)
IP3 → Special-purpose communication (special-purpose equipment)

Section 12 MEM Cable "MEM"

The TSL3000E/TSL3100E has a single USB port as standard.
A commercially available USB memory device can be used to transfer and save various parameters and back up programs and other data.
For details on USB memory operation, see the "Operation Manual".

Section 13 Connecting External I/O Power Supply Cable

The connection of the external I/O power supply cable uses the supplied connector ML-4000-CP-5PGY (connector). The connector is shared with the connector for connecting the I/O function extension unit, and supplies P24V power from the EXT I/O on the controller front panel.
The I/O that uses the external power supply (24 V DC) is shown below.

- External I/O
- External operation I/O
- Hand I/O
- Extension I/O

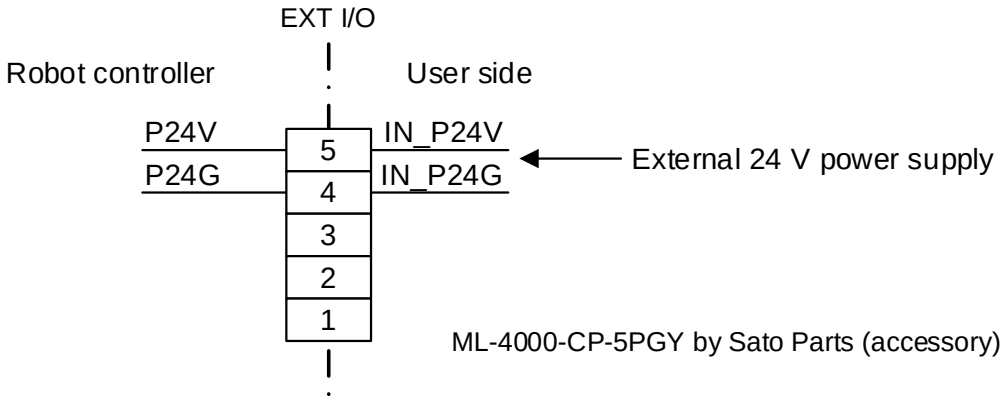


Fig. 13.1 Connection of external power supply

The compatible cable sizes for the connector are AWG24 to AWG16.
Select the optimum external power supply based on the system specifications (power capacity) of the customer.
For details on attaching and detaching the external I/O power supply cable, see Para. 7.3, "Attaching and Detaching External I/O Cable".

! CAUTION

Be sure to always connect an external power supply (24 V DC). Otherwise, the safety protection signals will not be valid, and the controller servo power cannot be turned on.

Appendix 1 System Signal Table

Name	I/O	Function	Signal judgment
STROBE	I	Selects an execution program file from the external equipment.	ON: Short-circuit OFF: Open
PRG_RST	I	Resets a program currently stopped to step 1. The value of each variable is also reset to "0".	ON: Short-circuit OFF: Open
STEP_RST	I	Resets a program currently stopped to step 1. The value of each variable remains unchanged.	ON: Short-circuit OFF: Open
CYC_RST	I	Resets a program currently stopped to the step labeled "RCYCLE". The value of each variable remains unchanged.	ON: Short-circuit OFF: Open
DO_RST	I	Batch-resets the digital output signals (DO_1 ~ DO_16, DO_101 ~ DO_120, DO_133 ~ DO_152).	ON: Short-circuit OFF: Open
ALM_RST	I	Cancels an alarm which has occurred while the robot controller was able to work.	ON: Short-circuit OFF: Open
RUN	I	Starts a program currently stopped to execute an automatic operation.	ON: Short-circuit OFF: Open
EX_SVON	I	Turns on the servo power.	ON: Short-circuit OFF: Open
RST-1 ~ RST-2	I	Resets latch from emergency stop status.	ON: Short-circuit OFF: Open
STOP	I	Stops a program during automatic operation.	ON: Open OFF: Short-circuit
CYCLE	I	Stops a program currently executed in automatic operation after one (1) cycle has finished.	ON: Open OFF: Short-circuit
LOW_SPD	I	Reduces the robot operating speed in automatic operation.	ON: Open OFF: Short-circuit
BREAK	I	Slows down and stops the ongoing robot operation.	ON: Open OFF: Short-circuit
SVOFF	I	Turns off the servo power.	ON: Open OFF: Short-circuit

Name	I/O	Function	Signal judgment
EMG-IN* ~ EMG-OUT*	I	Emergency-stops the robot.	ON: Open OFF: Short-circuit
SAD-IN* ~ SAD-OUT*	I	Emergency-stops the robot.	ON: Open OFF: Short-circuit
ACK	O	Serves as a response signal to input signals STROBE, PRG_RST, STEP_RST, CYC_RST and DO_RST.	ON: High OFF: Low
SV_RDY	O	This signal is output when the servo power is turned on and the robot is ready to start.	ON: High OFF: Low
EXTSIG	O	This signal is output when the EXT. SIGNAL mode is selected by means of the MODE switch.	ON: High OFF: Low
SYS_RDY	O	System ready signal	ON: High OFF: Low
AUTORUN	O	This signal is output while the program is executed in automatic operation.	ON: High OFF: Low
CYC_END	O	This is the output signal for verifying that the program has stopped by the CYCLE signal input.	ON: High OFF: Low
LOW_ST	O	This signal is output while the robot is operating at a low speed by the input of low speed command.	ON: High OFF: Low
BT_ALM	O	Battery voltage level error output for backup power supply.	ON: High OFF: Low
ALARM	O	Controller fault output.	ON: High OFF: Low
SVON-1a ~ SVON-COM	O	Servo power ON contact output.	ON: Contact open OFF: Contact close Non-voltage contact

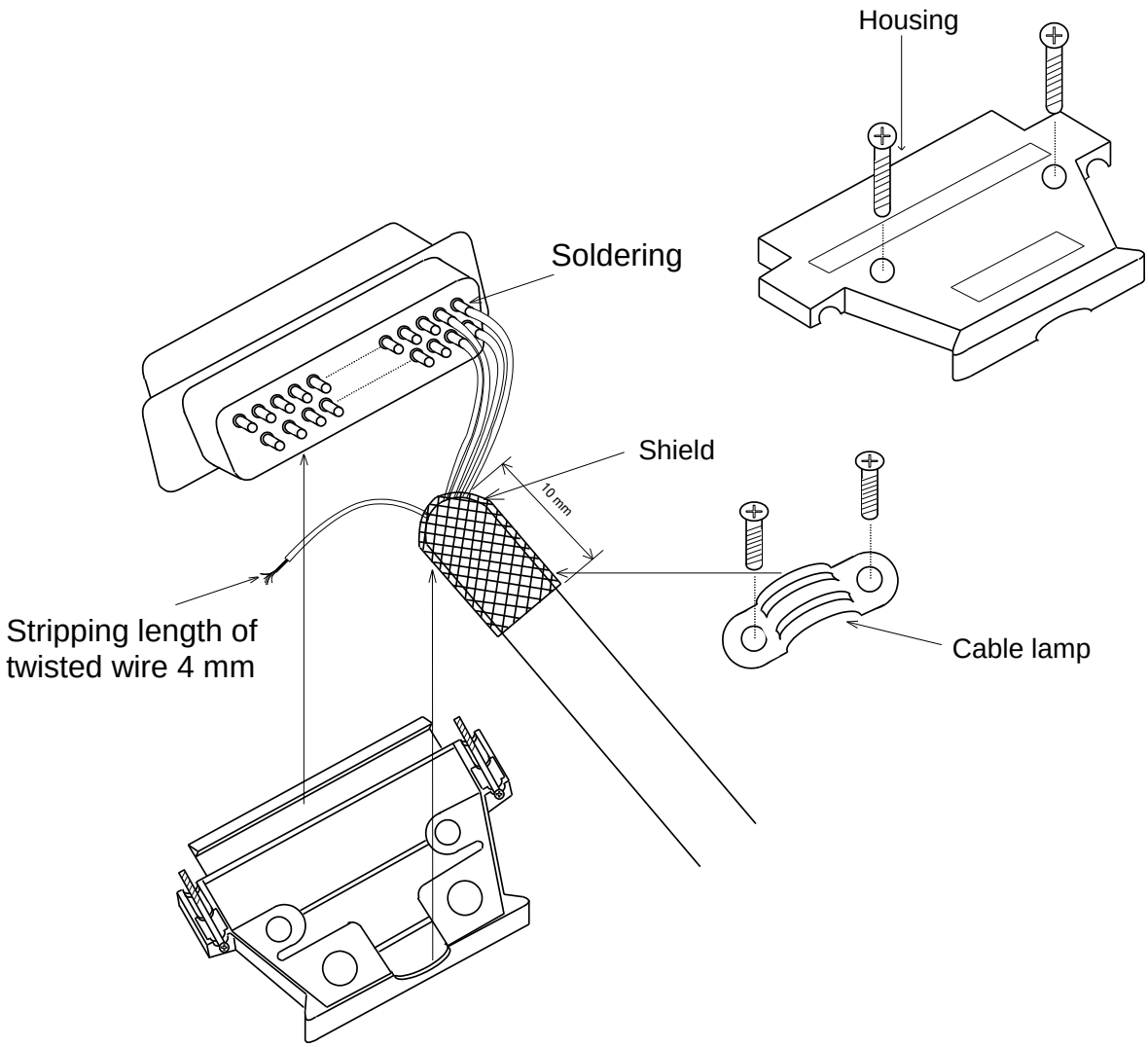
Name	I/O	Function	Signal judgment
EMG-COM* ~ EMG-*a, EMG-*b	O	Used to detect the EMERGENCY stop switch equipped on the teach pendant, and system input signal of emergency stop.	c-contact Non-voltage contact
SAD-COM* ~ SAD-*a, SAD-*b	O	Used to detect the enable switch equipped on the teaching pendant, and safety door input signal of emergency stop.	c-contact Non-voltage contact

I : Input signal

O : Output signal

Appendix 2 Fabricating Cable Using D-sub Connector

The cables to TSL3000E/TSL3100E external I/O signal connectors INPUT, OUTPUT, TR48DIOC module INPUT (TR), OUTPUT (TR), serial I/O signal connectors and hand I/O signal connector CN0 (robot side connections) should be fabricated as shown below.



Note: The shield wire of the cable using a D-sub connector is connected to the ground of the TSL3000E/TSL3100E robot controller through the housing. Completely connect the shield wire to the housing using the cable clamp. Also, it is recommended to attach a protective cover such as thermal contraction tube to the soldered part to prevent a short-circuit.